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The University of Southern Mississippi

# EFFECTS OF UNITED STATES DOMESTIC AGRICULTURAL GRAIN SUBSIDIES ON MEXICAN MIGRANT FLOWS

by

Pat Robert O'Brien

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

May 2013

ABSTRACT

EFFECTS OF UNITED STATES DOMESTIC AGRICULTURAL

GRAIN SUBSIDIES ON MEXICAN MIGRANT FLOWS

by Pat Robert O'Brien

May 2013

United States national, domestic feed grain subsidies have little effect on rural Mexican migration to the United States. This research shows the effect of the United States domestic feed grain subsidies on unbalanced trade with Mexico, the effect of unbalanced feed grain trade on poverty in rural Mexico, and the effect of Mexican rural poverty on Mexican migration to the United States.

The United States domestic agricultural infrastructure, including the United States General Services Support Estimate of subsidies, predict increased exports of corn to Mexico, but producer support subsidies to United States farmers do not.

Mexican estimates of poverty are based on the Instituto Nacional de Estadistica y Geografia (ENIGH) data and do not support an adverse economic impact on rural Mexico as a result of this trade imbalance with the United States. During the period studied the rates of rural Mexican poverty decreased.

Although Mexican migration to the United States has consistently increased, the rate is not shown to be predicted by lower economic conditions of the Mexican rural poor. Thus the potential causality of United States national, domestic feed grain subsidies on rural Mexican migration to the United States is not supported by the data.

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The University of Southern Mississippi

# EFFECTS OF THE UNITED STATES DOMESTIC AGRICULTURAL GRAIN SUBSIDIES ON MEXICAN MIGRANT FLOWS

by

Pat Robert O'Brien

A Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

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May 2013

# DEDICATION

I dedicate this work to my wife, Susan, for her acceptance of this task and constant encouragement in it, to my sons, Perry, Stephen, and Nathan, who made major life decisions during this time, and to my late father-in-law Dr. Perry Franklin Crawford, M.D., whose research and understanding of data and statistical processes encouraged my progress.

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Thank you to Dr. Pauly for his guidance early in my academic career and his effective teaching. Thank you to Dr. Butler, who seems to say the things I need to hear at appropriate times, for ensuring that seminars to further scholarship and prepare for graduation are continually provided. Thank you Dr. J.J. St. Marie, whose focused academic pursuits provided a human face that personified the academic discipline I seek to join, providing important critical insight, always upbeat and encouraging. Thank you to Dr. Edward Sayre who consistently shows us how our research is relevant and current.

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I also wish to thank Dr. J. Richard Ellis and the faculty and administration of John Brown University for their support and encouragement in this endeavor. It is my hope that my subsequent scholarship and service will justify the investment of the academic community of The University of Southern Mississippi and demonstrate the effectiveness of their scholarship, teaching, and heart to others.

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LIST OF ABBREVIATIONS

| Term | Definition |
|---|---|
| AD | Antidumping, especially related to Chapter 19 of NAFTA |
| ARMS | United States Department of Agriculture, Agricultural Resource Management Survey |
| ARP | Acreage reduction programs |
| BLUE | Best Linear Unbiased Estimates |
| CDSOA | Continued Dumping and Subsidy Offset Act of 2000, unofficially known as the Byrd Amendment |
| CEPAL | Comisión Económica para América Latina y el Caribe; Economic Commission for Latin America and the Caribbean |
| CONEVAL | National Council for Evaluation of the Social Development Policy / El Consejo Nacional de Evaluación de la Política de Desarrollo Social. |
| CRP | Conservation Reserve Program |
| CSE | Consumer Support Estimate |
| CUSFTA | Canada-United States Free Agreement |
| CVD | Countervailing duties, especially related to Chapter 19 of NAFTA |
| CWB | Canadian Wheat Board |
| ENIGH | National Survey of Income and Expenditure |
| ERS | United States Department of Agriculture, Economic Research Service |
| EU | European Union |
| FAO | Food and Agriculture Organization of the United Nations |
| FAS | United States Department of Agriculture, Foreign Agricultural Service |
| FGT | Foster, Greer, and Thorbecke |

| | |
|---|---|
| FTA | Free trade area |
| GATT | General Agreement on Tariffs and Trade |
| GDF | Global Development Finance |
| GIPSA | United States Department of Agriculture, Grain Inspection, Packers and Stockyards Administration |
| INEGI | National Institute of Statistics, Geography and Informatics |
| Kg | Kilogram |
| Kg/ha | Kilograms per Hectare |
| $km^2$. | Square Kilometer |
| MAP | United States Department of Agriculture, Market Access Program |
| MMT | Million Metric Tons |
| MT/ha | Metric Tons per Hectare |
| MXN million | Million Mexican Pesos |
| NAFTA | North American Free Trade Agreement |
| NEM | New Economic Model |
| NOAA | National Oceanic and Atmospheric Administration |
| NTBs | Non-tariff barriers |
| OECD | Organization for Economic Cooperation and Development |
| OPR | Office of Population Research, Princeton University |
| PSE | Producer Support Estimate |
| PPP | Purchasing power parity |
| PTA | Preferential trading arrangement |
| SAGARPA | Servicio de Información y Estadística Agroalimentaria Pesquera |

| | |
|---|---|
| SEDLAC | Socio-Economic Database for Latin America and the Caribbean |
| SPP | Security and Prosperity Partnership |
| TSE | Total [agricultural] Services Support Estimate |
| U.S. | United States |
| URAA | Uruguay Round Agreement on Agriculture |
| USDA | United States Department of Agriculture |
| WDI | World Development Indicators |
| WTO | World Trade Organization |

# CHAPTER I

# INTRODUCTION

This research investigates the impact of national, domestic feed grain producer subsidies in the United States on rural Mexican emigration flows, including those into the United States, and summarizes the subsequent coping strategies of individuals, formal non-governmental and governmental sectors. It answers the questions what, if any, and how strong are the stimulus effects of imported subsidized feed grains on the emigration of the Mexican rural poor.

This research first establishes the extent to which United States domestic agricultural subsidies result in an unbalanced trade advantage of feed grain exports with Mexico under the rules of the North American Free Trade Agreement (NAFTA). There has been concern about the expected effects of United States domestic agricultural subsidy policy on rural Mexico, even prior to the scheduled January 2008 elimination of the remaining agricultural tariffs on corn and other products (Burstein 2007). Second, this research documents the extent of the economic impact on rural Mexico and the resulting displacement of agricultural workers from farms as a result of this trade imbalance. Lastly, this research evaluates migration trends in Mexico, especially those of the agricultural population from 1990 to 2010. The discussion applies Kuznets's (1955, 1971) theory of phases of development and migration theory to explain migration from rural communities to Mexican semi-urban areas, larger urban population centers, and locations of opportunity in the United States. This research also documents variables that explain why, though there is significant emigration, the Mexican rural population as percent of the nation, 24%, is not expected to decrease significantly through 2030

(Fussell 2004). The survival mechanisms of the rural Mexican culture are discussed, including changes in sources of income and increasing dissemination of information that provides awareness of limited domestic opportunities and motivation to the rural Mexican population to emigrate.

This paper shows the effect of the United States domestic feed grain subsidies on unbalanced trade, the effect of unbalanced trade on poverty in rural Mexico, and the effect of rural poverty on Mexican emigration. Distinctions between legal and illegal immigration are beyond the scope of this study. This study is to provide policy insight to factors which affect United States immigration that may otherwise have been overlooked in public policy development.

# CHAPTER II

# THE EFFECT OF U.S. DOMESTIC FARM SUBSIDIES ON UNBALANCED FEED GRAIN TRADE WITH MEXICO

## Introduction

From the early nineteenth century the populations of Central and South America have been engaged in a struggle against the more organized and intentional trade complex of the European continent and its children (Bulmer-Thomas 2003). The organizational infrastructure of industrialized countries is so ubiquitous it overwhelms competition in lesser developed countries, often ignorantly, as different sectors struggle in competitive environments.

## Review of the Literature

### *Theoretical Background*

Bhagwati (1990) provides insights into national motivations of competition in international trade by discussing a reciprocity that applies to all other nations and a reciprocity that applies to only a few. The first he identifies as non-discriminating multilateralism and the second as discriminating multilateralism, found in preferential trade agreements. He is especially concerned about the implementation of the "aggressive unilateralism" of strong economies against weaker competitors. Bhagwati (1994, 231) subsequently revisits whether free trade is a desirable objective of national policy. He notes that in addition to the factor market imperfections discussed by Smith, Mill, and Ricardo, product market imperfections are being emphasized in recent trade theory discussions. Developed countries fear that developing countries will use free trade to drive down the wages of unskilled labor, and developing countries fear a loss of level playing fields with free trade. Trefler (2004) places these issues in a temporal perspective, showing the conflict over implementation of free trade between displaced workers and stakeholders of closed plants who bear short-run adjustment costs and stakeholders of competitive plants and users of final and intermediate goods who reap long-run efficiency gains.

Despite established theory of the welfare improving value of free trade, it is not universally accepted. Bhagwati (1994) observes the development of successive General Agreement on Tariffs and Trade (GATT) round negotiations, which allows less developed nations restrictions of free trade, especially in factor markets that attest to the practice and belief in restricted trade. As developing countries implement protectionist practices developed countries implement non-tariff barriers (NTBs) in an attempt to balance the trade restrictions allowed in GATT for developing nations. Developing countries have a growing fear that as global trade increases unfair advantages will result in a permanent displacement of local skills. These fears challenge the theory of comparative advantage and result in vacillation of national outlook toward free trade, as seen in changes in public opinion about NAFTA in both the United States and Mexico during its tenure. Although the Factor Price Equalization and Stolper-Samuelson theorems (Stopler and Samuelson 1941) show the adverse impact of free trade on individual nations, Leontief (1953) demonstrates in his paradox that sometimes those factors that seem most scarce or overvalued compose a significant portion of a nation’s exports. Bhagwati (1994, 242) argues that free trade can overcome the scarce production factors argument of Stopler-Samuelson by increasing the individual and public wealth of trading nations, describing the effect as a “lifting-all-boats” of economies. This occurs as competition and discipline increase the overall efficiency of industries in countries involved in free trade.

Bhagwati, Greenaway, and Panagariya (1998) also compare regional trade groups to world-wide free trade under the World Trade Organization (WTO). These perspectives are important for Mexico, which implemented trade concessions to the United States and Canada in an attempt to gain market access, beginning with the Mexican National Development Plan implemented by President Carlos Salinas de Gortari in 1989. These same markets were subsequently open to significant competition from Asia and especially from the People's Republic of China in 2001, under very similar terms. Viner (1950) distinguishes between trade diversion and extension. Expected trade diversions of United States imports from Mexico under NAFTA were mitigated when China became a member of the WTO. The United States, however, remains Mexico's largest trading partner, and although Mexico does not possess labor cost advantages over the People's Republic of China, it does have a seven year head start in a trade treaty with the United States as a result of structural links dating from the mid-1960s in the Maquiladora and automobile manufacturing industries, and complementary borders providing appreciably lower transportation costs to Mexican exporters to the United States. Bhagwati notes that in addition to these advantages, "actual trade diversion . . . reflect[s] the underlying fundamentals [of] elasticities of substitution among products" (Bhagwati et al. 1998, 1132) and so enhances trade within NAFTA. There are costs of trade within a free trade agreement. Bhagwati describes the difficulty of implementing a fair trade agreement tariff policy with multiple component parts and levels of production among many countries and regions as a "spaghetti bowl" (Bhagwati et al. 1998, 1138), with multiple trade authorities implementing different domains within international trade agreements. Sawyer (2001) notes that there are significant compliance costs of obtaining duty free benefits of NAFTA and that some potential participants in this free trade regime may opt out as results of those costs. Krishna (1998) concludes that participation in preferential trading arrangements in NAFTA is driven by lobbying of concentrated interest groups and diverts trade from a multinational context to one among trading partners.

Krueger (1999) compares national protectionist policies, in the context of preferential trading arrangements (PTAs), to multilateral trade arrangements. The Uruguay Round allows PTAs under certain restrictions. Both Krueger (1999) and Nguyen, Perroni, and Wigle (1993) agree that the Uruguay Round does not comprehensively address tariff and non-tariff trade barriers on agriculture. As noted earlier, PTAs are often borne out of political pressures, and while the formation of the Canada-United States Free Agreement (CUSFTA) occurred without fanfare, the political rhetoric “attracted by Mexican accession was entirely disproportionate to the economic magnitude of the event” (Krueger 1999, 108). Trade between Mexico and the United States grew significantly following the implementation of NAFTA. Krueger (1999, 113) notes that within the context of PTAs, “Little has been done analytically or empirically to evaluate the efficiency costs of having different areas of an FTA confronted by different prices of intermediate products.” Krueger also notes the importance of the proximity of trading partners. A situation of comparative advantage of the United States and Canada with Mexico does exist and can be exploited to increase the welfare of all NAFTA members. The free tariff environment within NAFTA does have a magnetic effect on footloose industries which may choose to relocate in Mexico from non-NAFTA locations. Krueger (1999) discusses national protectionist's motivations for adopting a PTA such as keeping non-member countries out, but does not address how a principal member of a PTA, such as the United States can abuse that agreement against a weaker economic power, such as Mexico. Krueger, more tolerant of allowing PTAs than Bhagwati, expresses concern that most of the research on the effects of NAFTA has been done within the context of a computable general equilibrium. Though Kruger sees some aspects in which PTAs are "stepping-stones" to freer trade (Kruger 1999, 122), Bhagwati sees them as "stumbling blocks" to international free trade (Kruger 1999, 122).

Krugman and Venables (1995) contend that within international trade arrangements transportation costs affect the real income of the nations involved. They demonstrate that as transportation costs fall below a critical value, a core-periphery of developing nations interacting with a central more economically developed nation spontaneously forms. When this occurs, developing peripheral nations suffer a decline in real income. They also note that if these transportation costs continue to decrease there is eventually a convergence of real incomes among the nations involved.

Hufbauer and Schott (2008) describe the trade regime under NAFTA as successful, tripling trade between the three nations to $900 billion. There are some losers. Jobs were lost, wages were depressed in some sectors, and emigration from Mexico was not adequately addressed. They cite that causes of failure subsequent to NAFTA involved Mexican governmental failure to deliver tax and energy reforms, failure to fund education infrastructure in Mexico, and failure of the National Mexican government to eradicate corruption. They encourage a commitment by the Mexican National government to provide training and opportunity for displaced Mexican labor. The United

States Department of Agriculture, Economic Research Service, *NAFTA at 13: Implementation Nears Completion* (2007) notes that the longest tariff transition period of NAFTA, fourteen years, was extended to corn as a major component of the rural agricultural sector economy to allow time for labor and industry adjustment to changes brought about by NAFTA.

*Concern from Mexico*

The conference and Working Group on U.S.-Mexico Agricultural Issues, documented by Burstein (2007), convened by the Woodrow Wilson Center and Fundacion IDEA in April 2007, provides preliminary discussion into the expected effects of United States domestic agricultural subsidy policy on rural Mexico with the scheduled January 2008 elimination of the remaining agricultural tariffs on corn, beans, sugar, and other products. The World Bank's *World Development Report 2008: Agriculture for Development* (2007) examines agriculture as a tool for development and provides a guide to unanswered issues of this subsidy-induced trade imbalance, including the negative economic impact on rural Mexico and the displacement of agricultural workers from farms.

Napoles (2007) observes that the evidence of Mexico's welfare following the implementation of free trade regimes is mixed. Carlsen (2008) notes that many in Mexico fear that the implementation of the Security and Prosperity Partnership (SPP) and Plan Mexico, virtual extensions of NAFTA, were motivated by and resulted in political control, not the economic welfare of Mexican citizens.

*Activities in and Explanation from the United States*

The profit motive for organizations in a perfectly competitive market, such as agriculture, is limited to cost reduction of production efforts. The United States Department of Agriculture, Economic Research Service, *Feed Grains Backgrounder* (2007) documents government support programs that provide sources of funding that reduce cost outlay and enhance productive facilities. Safety net programs, income support, and crop and revenue insurance have provided direct support to feed grain operators. Other programs of environmental stewardship and demand enhancement policies, such as those that incentivize ethanol production, provide indirect support. These policies have impacted feed grain production through acreage reduction programs (ARP), the Conservation Reserve Program (CRP), and planting provisions under successive farm legislation. The United States Department of Agriculture, Economic Research Service, *Feed Grains Backgrounder* (2007) notes that the United States domestic corn production is increasing and other feed grains are diminishing as subsidies and incentives for corn continue to increase. Government payments account for as much as 8 percent of average gross cash income for feed grain farms. The United States Department of Agriculture (USDA), Agricultural Resource Management Survey (ARMS) data for 2003 show that 70 percent of feed grain farms cover cash expenses from gross cash income. Without government payments, 8 percent fewer feed grain farms would cover their cash costs. The United States Department of Agriculture, Economic Research Service, *Feed Grains Backgrounder* (2007) notes that in addition to government subsidies, a complete supporting feed grain infrastructure has developed with formal markets and organizations such as the USDA's Grain Inspection, Packers and Stockyards

Administration (GIPSA), which provides standards for product evaluation and more efficient capital markets.

In addition to sector survival subsidies, trade-related programs for feed grain producers lower costs and increase profitability of feed grains exported. The United States Department of Agriculture, Economic Research Service and the United States Department of Agriculture, Foreign Agricultural Service list United States government trade-related programs, which include export Credit Guarantee programs, help finance commercial exports of United States agricultural products, and the Market Access Program (MAP), which develops, maintains, and expands United States agricultural exports. The USDA, FAS also documents food aid in the form of direct donations and concessional programs. These programs provide direct United States government purchases, which result in increasing product demand and, subsequently, prices. They include the Food for Peace, Food for Progress Act, and the McGovern-Dole International Food for Education and Child Nutrition Program, paying for United States commodities donated to developing countries and emerging democracies.

There are some international trade conflicts with United States subsidies. The United States Department of Agriculture, Economic Research Service, *Feed Grains Backgrounder* (2007) notes that while the United States government supports its domestic feed grain sector, the World Trade Organization (WTO) is concerned with market access, domestic support issues, and renewable energy policy. Blonigen (2006) contends that the United States dumping margins rose significantly from 1980 to 2000, attributing much of this increase to the discretionary practices of the United States Department of Commerce. Knox (2006) notes that of the four dispute resolution mechanisms outlined in the NAFTA, the most active is NAFTA Chapter 19 Antidumping (AD) and countervailing duties (CVD). Schnepf (2010) documents the 2002 Farm Act challenged during the United States WTO cotton case and that the WTO panel ruled that United States direct payments for cotton did not meet the definition of decoupled payments as specified by the Uruguay Round Agreement on Agriculture (URAA), which deemed that there be no restrictions on the choice of crops grown by the producer. Bhagwati and Mavroidis (2004) document the reaction of the WTO Appellate Body against the antidumping provision of the Byrd Amendment, officially known as the Continued Dumping and Subsidy Offset Act of 2000 (CDSOA), because it was not included in the three forms of duties noted in the WTO Antidumping Agreement. Bhagwati and Mavroidis also contend that substantively the Byrd Amendment violated the WTO Antidumping Agreement because, "by over-compensating (allegedly) injured private parties, the United States turns the tables and disturbs the 'level playing field,' this time to the advantage of its nationals" (Bhagwati and Mavroidis 2004, 120) The United States Department of Agriculture, Economic Research Service, *Feed Grains Backgrounder* (2007) also notes that the international emphasis on conservation and environmental programs may allow continued direct payments within the United States; considered "green box" by the WTO (2007, 39). The Hong Kong Ministerial Agreement in December 2005 called for reductions in trade-distorting domestic support, elimination of export subsidies, and increased market access. The United States has agreed to limit trade-distorting domestic support, and this is expected to affect feed grain producer loan benefits and crop insurance subsidies, but the United States is concerned about equitable treatment in market access, domestic support, export subsidies, and technical barriers to trade.

The United States implements five interconnected national food aid programs under the direction of the United Stated Department of Agriculture and United States Agency for International Development, which purchase agriculture products from producers in the United States. They include the Food for Progress Program, the McGovern–Dole International Food for Education and Child Nutrition Program, the Food for Peace Act (formerly referred to as Public Law 480, Titles I, II, and III), Section 416(b), and the Local and Regional Procurement Project (USDA, Foreign Agricultural Service, Food Aid). These food stocks are obtained through a national agricultural repository of commodities known as the Bill Emerson Humanitarian Trust, named in honor of the late Representative Bill Emerson of Missouri who served as ranking member of the House Select Committee on Hunger (Hanrahan 2003). These purchases from United States producers represent a significant guarantee/subsidy to these producers.

John Hays describes price supports as “the last bastion of United States and European protectionism” (2011, ii). He includes food aid as an export subsidy and posits that “dumping of agricultural products on the markets of less developed countries, at prices lower than these products can be locally grown, is detrimental to the farmers of these nations” (Hays 2011, 261). Hays wonders under which conditions it would be better for these countries if the aid was in cash instead of agricultural products.

*Dual Agricultural Systems*

Addressing the effects of agricultural grain subsidies requires review of the respective agricultural systems of the countries considered. The agricultural system of

Mexico is defined by its production capabilities, consumption practices, and the transformational changes resulting from international pressures. The United States and Mexico have different agricultural systems and these differences influence trade balances. The United States focuses primarily on feed grain for animal production with predominately yellow dent corn. Mexico focuses its corn production efforts primarily toward consumer foods made from white corn (United States Department of Agriculture, Economic Research Service, *U.S.-Mexico Corn Trade during the NAFTA Era: New Twists to an Old Story* 2004). On average, the United States produced 14.5 times the total annual production tonnage of corn for 2007 through 2010 of Mexico. While the United States produces 15.4 percent more total annual tonnage than it consumes during this period, Mexico runs a 38.9 percent average total annual deficit, consuming more than it produces (United States Department of Agriculture, Foreign Agricultural Service, 2012. Table 5: World Corn Production, Consumption, and Stocks).

Corn is grown in all of the states of Mexico. Between 1999 and 2010 an average of 39 percent of the total cultivated area in Mexico was devoted to corn production (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, Servicio de Información y Estadística Agroalimentaria Pesquera (SAGARPA/SIAP Statistics of Agricultural Production by Crop). 2011 Agricultural Yearbook 2011). Seventy percent of Mexican corn production, however, is from eight states: Chiapas, Guerrero, Jalisco, Mexico, Michoacán, Puebla, Sinaloa, and Veracruz (Mejia and Peel 2009a).

The Mexican agricultural system is composed of large commercial, medium communal (*ejidos*), small and very small subsistence farms. Farming systems also vary in farming practice, whether they irrigate or use dry land farming techniques (rain fed).

Although much of the corn farming in the United States is without irrigation, the corn producing regions in the United States experience significantly more and consistent rainfall than most of the farming regions of Mexico, which tend to be semi-arid (Mejia and Peel 2009b). Klepeis and Vance (2003) note more successful farms in terms of efficiency and total production are located where irrigation is used. The United States Department of Agriculture, Economic Research Service, *U.S.-Mexico Corn Trade during the NAFTA Era: New Twists to an Old Story* (2004) notes only 9 percent of Mexican farmers have access to irrigation. Between 1999 and 2010 an average of 26.14 percent of the total cultivated area in Mexico receives irrigation (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, Servicio de Información y Estadística Agroalimentaria Pesquera (SAGARPA/SIAP Statistics of Agricultural Production by Crop). 2011 Agricultural Yearbook 2011). Larger Mexican farms tend to rely on technology inputs such as hybrid seed corn, fertilizer, and herbicides (Vilas-Ghiso and Liverman 2007), while smaller and subsistence farms rely on manure for fertilizer, original landrace seeds, and manual cultivation to eliminate weeds (Keleman 2010). Large Mexican farms employing advanced growing techniques with costly inputs reap higher yields, and smaller farms with limited inputs produce at a much lower cost, but reap significantly lower yields (Mejia and Peel 2009a). The United States Department of Agriculture, Economic Research Service, *U.S.-Mexico Corn Trade during the NAFTA Era: New Twists to an Old Story* also notes that only 31 percent of Mexican farms use "improved varieties of corn" (2004, 5).  United States farms are increasingly monoculture growth systems and rely almost exclusively on commercially provided seed and fertilizers (Hendrickson, James, and Heffernan 2008). Farmers in the United States are increasingly leasing land to large farming operation companies, which subsequently control all phases of production (United States Department of Agriculture, Economic Research Service. *Trends in U.S. Farmland Values and Ownership* 2012). Mejia and Peel (2009a) note that large commercial and medium sized farms in Mexico grow both white and yellow corn and that yellow corn has higher yields. They also observe that "all [Mexican] states experience higher profits [using] commercial production [techniques in] growing both white and yellow corn" (Mejia and Peel 2009a, 17). Successful yellow corn production requires technology, improved seed varieties, fertilizer, pest agrochemicals, access to water, and management (Mejia and Peel 2009a). Between 1999 and 2010 an average of 3.4 percent of the total cultivated area in Mexico was devoted to yellow corn production, of this 40.4 percent was irrigated (SAGARPA 2011). Larger Mexican farm operations have access to finances and risk reduction strategies unavailable to smaller Mexican farms (United States Department of Agriculture, Economic Research Service, *U.S.-Mexico Corn Trade during the NAFTA Era: New Twists to an Old Story* 2004). Crop rotation used in the United States to replenish soil nutrients and reduce soil erosion is somewhat impractical for small farms in Mexico. "Traditional corn producers in Mexico often do not have the management skills or the equipment necessary to capitalize on the yield and profit potential of yellow corn" (Mejia and Peel 2009b, 4). Smaller producers in arid and in high altitudes with harsher and more variable environments, however, use locally adapted seeds and farming techniques (Mejia and Peel 2009b).

Boland, Dhuyvetter, and Marshall (2002) observe that most Mexican corn is grown in regions remote from locations in which it is milled and consumed. It is harvested twice each year, consumed throughout the year, but storage facilities are lacking in Mexico. Most United States farmers have access to product storage facilities. These storage facilities allow United States farmers to sell harvested corn at optimal prices and provide continuous delivery of product beyond harvest seasons. During periods of drought Mexican imports of corn increase. Mexico is also experiencing a growing livestock industry as the changing income elasticity of demand of consumers is resulting in more demand for meat and relatively less for grain foods. Livestock sector growth demands yellow corn for beef, poultry production, cereal, and beer since 1993 have been increasing (United States Department of Agriculture, Economic Research Service, *U.S.-Mexico Corn Trade during the NAFTA Era: New Twists to an Old Story* 2004).

Mexican corn production is inefficiently organized. Farm gate prices are low and intermediaries capture large profits (United States Department of Agriculture, Economic Research Service, *U.S.-Mexico Corn Trade during the NAFTA Era: New Twists to an Old Story* 2004). Market failures occur because of lack of technology, market intermediaries, corruption, low yield, and inefficiency in the marketing system and structural problems that prevent transition from subsistence to market based agricultural systems (United States Department of Agriculture, Economic Research Service, *U.S.-Mexico Corn Trade during the NAFTA Era: New Twists to an Old Story* 2004). Yellow corn production in Mexico has increased from below 1 percent of total planted area in 2000 to 4.7 percent in 2010 (SAGARPA 2011). Echánove and Steffen (2005) note restrictions *ejidatarios* (members of a communally owned farm) face with access to water for their crops. Cohen (2001, 957) notes “the Mexican government's agrarian policies that favored large-scale irrigation projects over family farms (*minifundios*) producing largely for self-consumption."

Mejia and Peel note that yellow corn is a good crop "alternative because of the higher profit potential" (2009b, 6) but yellow corn requires "adequate water and much of the yellow corn is grown on the limited amount of irrigated land available in Mexico (2009b, 7). "Much corn is grown in high altitudes or in other diverse climate conditions for which there is no locally adapted yellow corn varieties" (2009b, 7). Boyd and Ibarraran (2008, 374) discuss the "increasing the intensity of extreme weather events."

Mexican domestic demand outpaces its supply. Consumption practices in Mexico are rooted in cultural heritage and national identity (Mejia and Peel 2009b) but are changing partially due to changing income elasticity and partially due to cultural influences of developed countries (Schmidhuber and Prakash 2005). Boland et al. (2002) note that uses for white corn include food-grade starch and paper, tortilla chips, and tortillas. Corn production in Mexico increases over the period studied, but consumer demand is increasing more rapidly. Mexico is the fourth largest producer and third largest consumer of corn in the world (USDA, FAS 2012). Mexico is increasingly dependent on imports. During1986–2007 Mexican corn production increased from 10.0 to 20.5 million metric tons (MMT) and corn imports increased from 1.7 to 9.8 MMT (USDA, ERS database 2011).

The United States Department of Agriculture, Economic Research Service, *U.S.-Mexico Corn Trade during the NAFTA Era: New Twists to an Old Story* (2004) notes that the Mexican starch industry consumes yellow corn imported from the United States, and large flour companies are increasing this role in tortilla production. United States yellow corn exports to Mexico are increasingly used in animal feed but are also used to "manufacture ethanol, high-fructose corn syrup, corn starch and other products" (United States Department of Agriculture, Economic Research Service, *U.S.-Mexico Corn Trade during the NAFTA Era: New Twists to an Old Story* 2004, 2). The report also suggests that yellow and white corns are interchangeable in some of these processes.

Mejia and Peel (2009a) note that white and yellow corn began to be distinguished in the international trade data beginning in 2005. They also observe that yellow corn production in Mexico has become increasingly more attractive as domestic and world demand for yellow corn increase. Lower Mexican efficiency and production of yellow corn, however, result in Mexican food industries importing lower cost international corn rather than purchasing this commodity from domestic sources.

Constance (2012) notes that although ethanol production in Mexico is still negligible, ethanol production may grow within the Mexican agricultural system and cause even more reliance on foreign sources of corn supply for animal feed and consumer food. This change may cause significant supply shocks to the food supply, subsequently raising prices and inordinately affecting the Mexican poor. The United States Department of Energy data on Mexican biodiesel and ethanol fuel production from 2007 to 2010 ranges from 36,500 to 146,000 barrels per year. This compares with 167 million to 324 million barrels in the United States per year over the same period. Environmental concerns in Mexico of the impact on environmental quality similar to that experienced in the *dead zone* of the northern Gulf of Mexico may direct national goals away from ethanol production in an effort to reduce nitrogen and phosphorous as recommended for the United States by Simpson et al. (2007). This *dead zone*, or area of hypoxia (depletion of oxygen required to support marine life), is caused by excessive nutrient pollution covering from 1,197 to 6,213 square miles of the Gulf of Mexico at the mouth of the Mississippi River (United States Department of Commerce, National Oceanic and Atmospheric Administration 2012). Babcock and Fabiosa (2011), modeling ethanol production from 2005 through 2009, demonstrated that although ethanol production affects United States domestic corn prices, other commodity market prices and supplies affect the price of corn more significantly.

The impact of the third member of NAFTA, Canada, merits review with respect to the interaction of its corn industry with that of Mexico. The Canadian Wheat Board (Canadian Wheat Board 2012) provides a summary of the history and focus of Canadian government price supports. Canada has nationalized grain market prices since 1934, and this effects trade with United States and Mexico. Most of the trade tensions, however, occur between the western provinces of Canada and the north central plains states in the United States. Although the Canadian Wheat Board (CWB) controlled corn commodity prices during World War II, only wheat and barley are currently controlled and centrally priced by the CWB. The CWB does specify corn product quality for the Canadian Grain Commission under the Canada Grain Regulations – Section 5 and in that sense influences Canadian corn production. (Canadian Grain Commission 2012).

Canadian production capacity and domestic need for corn mitigate Canadian influence on corn production and corn imports in Mexico. Despite Canadian government influences on corn production, Canadian production tonnage from 2007 to 2011 are only 49 percent of Mexican corn production and only 3.4 percent of United States corn production, and as such has only marginal impact on NAFTA corn trade. Canadian corn producers provide 90 percent of domestic consumption (USDA, FAS 2012).

## Theoretical Framework

Feed grain trade imbalances under NAFTA between the United States and Mexico are affected by multiple variables. To determine the strength and likelihood of effect a regression of these variables is evaluated for each of the years 1986 through 2007. Annual Mexican imports of corn from the United States, measured in 1,000 metric tons per year, are used as a proxy for unbalanced feed grain trade, the dependent variable. Each of the seven independent variables is a ratio that reflects reductions in cost or increases in productivity between the United States and Mexico that are expected to impact corn imports. The ratio of total corn production in each country reflects national capacity of available arable land and cost/benefit decisions of land use. Productivity of land and yield, (which measures efficiency as a ratio of average metric tons of harvested corn per hectare) United States/Mexico reflects the soil and climate effects. Natural soil productive capacity affects costs of production that may not be related to other inputs or market effects of trade.

Technology is measured as the ratio of tons of fertilizer used per hectare of arable land, and farm machinery equipment, measured as the ratio of tractor count per 100 square kilometers of arable land.  These two measures quantify the ratio of United States/Mexico invested working capital. The United States Department of Agriculture, Economic Research Service, *Feed Grains Backgrounder* (2007) contends that technology provides efficiency in agricultural production.

National government subsidies of the farm sector can affect and unbalance trade. Two comprehensive measures of agricultural subsidies are the Producer Support Estimate (PSE) and the General Services Support Estimate (GSSE) noted by the Organization for Economic Cooperation and Development (OECD). These, with the Consumer Support Estimate (CSE), comprise a Total [agricultural] Services Support Estimate (TSE) of a nation. The PSE measures the “annual monetary value of gross transfers . . . to support agricultural producers, measured at farm gate . . .” (Organization for Economic Cooperation and Development 2003, under “Glossary of Statistical Terms, Producer Support Estimate (PSE)”). The GSSE contains support of research and development, agricultural schools, inspections services, infrastructure, marketing and promotion, public stockholding, and some miscellaneous agricultural payments. The GSSE measures other “annual monetary value of gross transfers to services provided collectively to agriculture and arising from policy measures which support agriculture, regardless of their nature, objectives and impacts on farm production, income, or consumption of farm products” (Organization for Economic Cooperation and Development 2003, under “Glossary of Statistical Terms, General Services Support Estimate (GSSE)”). PSE and GSSE ratios of United States/Mexico reflect government financial involvement in agriculture and effects of international trade markets. The impact of domestic subsidies on agricultural products is attested by Bhagwati and Mavroidis (2004), Stiglitz and Charlton (2005), and Burstein (2007).

## Methodology

United States agricultural policy with the wide and deep array of domestic grain subsidies may reduce Mexico’s competitive position with the United States in labor costs and other costs of grain production. This research addresses this effect at a composite level, assessing whether and to what extent this occurs. United States domestic subsidies and other agricultural production advantages adversely affect the trade balance in feed grains, especially maize, in Mexico. Hypotheses are:

$H_1$: The relative increase of United States domestic producer support subsidies compared to Mexico result in negative corn trade balances for Mexico with the United States, under NAFTA.

$H_2$: The relative increase of United States domestic general services support subsidies compared to Mexico result in negative corn trade balances for Mexico with the United States, under NAFTA.

$H_3$: The relative increase of United States domestic consumer support subsidies compared to Mexico result in negative corn trade balances for Mexico with the United States, under NAFTA.

$H_4$: The relative increase of United States domestic corn production compared to Mexico results in negative corn trade balances for Mexico with the United States, under NAFTA.

$H_5$: The relative increase of United States domestic corn production efficiency compared to Mexico results in negative corn trade balances for Mexico with the United States, under NAFTA.

$H_6$: The relative increase of United States agricultural use of fertilizer compared to Mexico results in negative corn trade balances for Mexico with the United States, under NAFTA.

$H_7$: The relative increase of United States agricultural use of farm equipment compared to Mexico results in negative corn trade balances for Mexico with the United States, under NAFTA.

The data for Mexican imports of United States corn are from the United Nations Food and Agriculture Organization for 1986 through 1988, and from the United States Department of Agriculture, Economic Research Service for 1989 through 2007. Feed grain production data are obtained from the United States Department of Agriculture, Foreign Agricultural Service. Technology data for fertilizer consumption and machinery use are from the United Nations Food and Agriculture Organization. Producer Support Estimates (PSE), General Services Support Estimates (GSSE), and Consumer Support Estimates (CSE) are from the Organization for Economic Cooperation and Development (OECD).

Feed grain trade imbalances under NAFTA between the United States and Mexico are evaluated using linear multiple regression addressing multiple causal variables each of the years 1986 through 2007. This is shown as:

$$Y = B_0 + B_1x_1 + \ldots B_nx_{tn} + U_t$$

Such that, UFGT = f (P, L, F, T, PS, GS, CS), where UFGT is the dependent variable of corn imports from the United States into Mexico measured in 1,000 metric tons per year (Table 1).

Table 1

*Data Sources – Mexican Corn Imports from the United States*

| Year | Corn Imports (1,000 Metric Tons) |
|---|---|
| 1986 | 1,703.58 |
| 1987 | 3,602.90 |
| 1988 | 3,301.83 |
| 1989 | 4,856.05 |
| 1990 | 2,028.08 |
| 1991 | 918.79 |
| 1992 | 520.98 |
| 1993 | 1,479.55 |
| 1994 | 3,001.74 |
| 1995 | 6,477.19 |
| 1996 | 3,161.57 |
| 1997 | 4,126.88 |
| 1998 | 5,453.89 |
| 1999 | 4,804.24 |
| 2000 | 5,944.55 |
| 2001 | 4,517.34 |
| 2002 | 5,288.34 |
| 2003 | 5,682.53 |

Table 1 (continued).

| Year | Corn Imports (1,000 Metric Tons) |
|---|---|
| 2004 | 5,885.48 |
| 2005 | 6,335.94 |
| 2006 | 8,767.87 |
| 2007 | 9,817.61 |

Note: Source: United States Department of Agriculture, Economic Research Service.

P reflects national capacity as the ratio of United States to Mexican annual corn production measured in 1,000 metric tons per year. L reflects efficiency as the comparative yield ratio of the United States to Mexico measured in average metric tons per hectare. Both are shown in Table 2.

Table 2

*Data Sources – Production*

| Year | U. S. Production 1,000 Metric Tons | Mexico Production 1,000 Metric Tons | U.S./Mexico Production Ratio | U.S. Yield (MT/ha) | Mexico Yield (MT/ha) | U.S./Mexico Yield Ratio |
|---|---|---|---|---|---|---|
| 1980 | 168,648 | 10,400 | 16.22 | 1.28 | 5.71 | 4.46 |
| 1981 | 206,223 | 12,500 | 16.50 | 1.53 | 6.84 | 4.47 |
| 1982 | 209,181 | 7,000 | 29.88 | 1.17 | 7.11 | 6.08 |
| 1983 | 106,031 | 9,300 | 11.40 | 1.43 | 5.09 | 3.56 |

Table 2 (continued).

| Year | U. S. Production 1,000 Metric Tons | Mexico Production 1,000 Metric Tons | U.S./Mexico Production Ratio | U.S. Yield (MT/ha) | Mexico Yield (MT/ha) | U.S./Mexico Yield Ratio |
|---|---|---|---|---|---|---|
| 1984 | 194,881 | 9,900 | 19.68 | 1.57 | 6.70 | 4.27 |
| 1985 | 225,447 | 10,500 | 21.47 | 1.69 | 7.41 | 4.38 |
| 1986 | 208,944 | 10,000 | 20.89 | 1.67 | 7.49 | 4.49 |
| 1987 | 181,143 | 9,900 | 18.30 | 1.65 | 7.52 | 4.56 |
| 1988 | 125,194 | 10,100 | 12.40 | 1.68 | 5.31 | 3.16 |
| 1989 | 191,320 | 9,750 | 19.62 | 1.68 | 7.30 | 4.35 |
| 1990 | 201,534 | 14,100 | 14.29 | 2.14 | 7.44 | 3.48 |
| 1991 | 189,868 | 14,689 | 12.93 | 2.10 | 6.82 | 3.25 |
| 1992 | 240,719 | 18,631 | 12.92 | 2.47 | 8.25 | 3.34 |
| 1993 | 160,986 | 19,276 | 8.35 | 2.49 | 6.32 | 2.54 |
| 1994 | 255,295 | 16,994 | 15.02 | 2.12 | 8.70 | 4.10 |
| 1995 | 187,970 | 17,780 | 10.57 | 2.29 | 7.12 | 3.11 |
| 1996 | 234,518 | 18,922 | 12.39 | 2.30 | 7.98 | 3.47 |
| 1997 | 233,864 | 17,368 | 13.47 | 2.41 | 7.95 | 3.30 |
| 1998 | 247,882 | 17,789 | 13.93 | 2.26 | 8.44 | 3.73 |
| 1999 | 239,549 | 19,240 | 12.45 | 2.66 | 8.40 | 3.16 |
| 2000 | 251,854 | 17,917 | 14.06 | 2.51 | 8.59 | 3.42 |
| 2001 | 241,377 | 20,400 | 11.83 | 2.62 | 8.67 | 3.31 |

Table 2 (continued).

| Year | U. S. Production 1,000 Metric Tons | Mexico Production 1,000 Metric Tons | U.S./Mexico Production Ratio | U.S. Yield (MT/ha) | Mexico Yield (MT/ha) | U.S./Mexico Yield Ratio |
|---|---|---|---|---|---|---|
| 2002 | 227,767 | 19,280 | 11.81 | 2.74 | 8.12 | 2.96 |
| 2003 | 256,229 | 21,800 | 11.75 | 2.83 | 8.92 | 3.15 |
| 2004 | 299,876 | 22,050 | 13.60 | 2.87 | 10.06 | 3.51 |
| 2005 | 282,263 | 19,500 | 14.48 | 2.94 | 9.29 | 3.16 |
| 2006 | 267,503 | 22,350 | 11.97 | 3.03 | 9.36 | 3.09 |
| 2007 | 331,177 | 23,600 | 14.03 | 3.22 | 9.46 | 2.94 |
| 2008 | 307,142 | 24,226 | 12.68 | 3.31 | 9.66 | 2.92 |
| 2009 | 332,549 | 20,374 | 16.32 | 3.24 | 10.34 | 3.19 |
| 2010 | 316,165 | 21,130 | 14.96 | 3.02 | 9.59 | 3.18 |
| 2011 | 313,918 | 20,500 | 15.31 | 3.08 | 9.24 | 3.00 |

Note: Source: United States Department of Agriculture, Foreign Agricultural Service, Production, Supply and Distribution Online (PSD)

Technology effects are measured by F, the United States/Mexico ratio of kilograms of fertilizer used per hectare of arable land. Mexico data is found in Table 3, and United States and the United States/Mexico ratios in Table 4. Technology effects are also measured by T, the United States/Mexico ratio of tractors per 100 square kilometers of arable land (Table 5). Each of these tables presents data from the Food and Agricultural Organization of the United Nations.

Table 3

*Data sources – Technology, Fertilizer Consumption - Mexico*

| Year | Total Fertilizer Consumption (tons) | Total Fertilizer Consumption (kg) | Arable land (sq. km) | Arable land (Hectare) | Fertilizer kg/ha |
|---|---|---|---|---|---|
| 1980 | 1,237,913 | 1,237,913,000 | 23,000 | 2,300,000 | 538.22 |
| 1981 | 1,560,985 | 1,560,985,000 | 23,050 | 2,305,000 | 677.22 |
| 1982 | 1,671,942 | 1,671,942,000 | 23,138 | 2,313,800 | 722.60 |
| 1983 | 1,485,800 | 1,485,800,000 | 23,138 | 2,313,800 | 642.15 |
| 1984 | 1,660,900 | 1,660,900,000 | 23,138 | 2,313,800 | 717.82 |
| 1985 | 1,764,100 | 1,764,100,000 | 23,300 | 2,330,000 | 757.12 |
| 1986 | 1,796,600 | 1,796,600,000 | 23,500 | 2,350,000 | 764.51 |
| 1987 | 1,887,880 | 1,887,880,000 | 23,700 | 2,370,000 | 796.57 |
| 1988 | 1,757,400 | 1,757,400,000 | 23,900 | 2,390,000 | 735.31 |
| 1989 | 1,739,900 | 1,739,900,000 | 24,100 | 2,410,000 | 721.95 |
| 1990 | 1,798,400 | 1,798,400,000 | 24,300 | 2,430,000 | 740.08 |
| 1991 | 1,619,400 | 1,619,400,000 | 24,450 | 2,445,000 | 662.33 |
| 1992 | 1,616,000 | 1,616,000,000 | 24,600 | 2,460,000 | 656.91 |
| 1993 | 1,591,900 | 1,591,900,000 | 24,800 | 2,480,000 | 641.90 |
| 1994 | 1,647,900 | 1,647,900,000 | 24,900 | 2,490,000 | 661.81 |
| 1995 | 1,286,000 | 1,286,000,000 | 25,100 | 2,510,000 | 512.35 |
| 1996 | 1,636,400 | 1,636,400,000 | 25,000 | 2,500,000 | 654.56 |
| 1997 | 1,644,100 | 1,644,100,000 | 25,000 | 2,500,000 | 657.64 |

Table 3 (continued).

| Year | Total Fertilizer Consumption (tons) | Total Fertilizer Consumption (kg) | Arable land (sq. km) | Arable land (Hectare) | Fertilizer kg/ha |
|---|---|---|---|---|---|
| 1998 | 1,804,300 | 1,804,300,000 | 25,100 | 2,510,000 | 718.84 |
| 1999 | 1,776,000 | 1,776,000,000 | 25,100 | 2,510,000 | 707.57 |
| 2000 | 1,832,000 | 1,832,000,000 | 25,100 | 2,510,000 | 729.88 |
| 2001 | 1,865,378 | 1,865,378,000 | 25,100 | 2,510,000 | 743.18 |
| 2002 | 1,512,561 | 1,512,561,000 | 25,100 | 2,510,000 | 602.61 |
| 2003 | 1,578,326 | 1,578,326,000 | 25,100 | 2,510,000 | 628.82 |
| 2004 | 1,699,189 | 1,699,189,000 | 25,100 | 2,510,000 | 676.97 |
| 2005 | 1,841,638 | 1,841,638,000 | 25,000 | 2,500,000 | 736.66 |
| 2006 | 1,611,570 | 1,611,570,000 | 24,500 | 2,450,000 | 657.78 |
| 2007 | 1,756,532 | 1,756,532,000 | 24,453 | 2,445,300 | 718.33 |
| 2008 | 1,203,288 | 1,203,288,000 | 25,202 | 2,520,200 | 477.46 |
| 2009 | 1,300,321 | 1,300,321,000 | 25,133 | 2,513,300 | 517.38 |

Table 4

*Data sources – Technology, Fertilizer Consumption – United States and U.S./Mexico Input Ratio*

| Year | Total Fertilizer Consumption (ton) | Total Fertilizer Consumption (kg) | Arable land (sq. km) | Arable land (Hectare) | Fertilizer kg/Ha | U.S./ Mexico Input Ratio |
|---|---|---|---|---|---|---|
| 1980 | 21,479,946 | 21,479,946,000 | 188,755 | 18,875,500 | 1137.98 | 2.11 |

Table 4 (continued).

| Year | Total Fertilizer Consumption (ton) | Total Fertilizer Consumption (kg) | Arable land (sq. km) | Arable land (Hectare) | Fertilizer kg/Ha | U.S./ Mexico Input Ratio |
|---|---|---|---|---|---|---|
| 1981 | 19,438,990 | 19,438,990,000 | 188,755 | 18,875,500 | 1029.85 | 1.52 |
| 1982 | 16,415,911 | 16,415,911,000 | 187,765 | 18,776,500 | 874.28 | 1.21 |
| 1983 | 19,767,528 | 19,767,528,000 | 187,765 | 18,776,500 | 1052.78 | 1.64 |
| 1984 | 19,688,206 | 19,688,206,000 | 187,765 | 18,776,500 | 1048.56 | 1.46 |
| 1985 | 17,830,541 | 17,830,541,000 | 187,765 | 18,776,500 | 949.62 | 1.25 |
| 1986 | 17,285,666 | 17,285,666,000 | 187,765 | 18,776,500 | 920.60 | 1.20 |
| 1987 | 17,792,358 | 17,792,358,000 | 185,742 | 18,574,200 | 957.91 | 1.20 |
| 1988 | 17,733,130 | 17,733,130,000 | 185,742 | 18,574,200 | 954.72 | 1.30 |
| 1989 | 18,709,234 | 18,709,234,000 | 185,726 | 18,572,600 | 1007.36 | 1.40 |
| 1990 | 18,586,936 | 18,586,936,000 | 185,676 | 18,567,600 | 1001.04 | 1.35 |
| 1991 | 18,784,000 | 18,784,000,000 | 185,676 | 18,567,600 | 1011.65 | 1.53 |
| 1992 | 18,991,000 | 18,991,000,000 | 184,080 | 18,408,000 | 1031.67 | 1.57 |
| 1993 | 20,349,600 | 20,349,600,000 | 182,748 | 18,274,800 | 1113.53 | 1.73 |
| 1994 | 19,297,270 | 19,297,270,000 | 181,939 | 18,193,900 | 1060.65 | 1.60 |
| 1995 | 20,037,976 | 20,037,976,000 | 181,839 | 18,183,900 | 1101.96 | 2.15 |
| 1996 | 20,310,309 | 20,310,309,000 | 179,006 | 17,900,600 | 1134.62 | 1.73 |
| 1997 | 20,165,250 | 20,165,250,000 | 177,592 | 17,759,200 | 1135.48 | 1.73 |
| 1998 | 19,773,874 | 19,773,874,000 | 176,782 | 17,678,200 | 1118.55 | 1.56 |

Table 4 (continued).

| Year | Total Fertilizer Consumption (ton) | Total Fertilizer Consumption (kg) | Arable land (sq. km) | Arable land (Hectare) | Fertilizer kg/Ha | U.S./ Mexico Input Ratio |
|---|---|---|---|---|---|---|
| 1999 | 19,563,478 | 19,563,478,000 | 175,368 | 17,536,800 | 1115.57 | 1.58 |
| 2000 | 18,794,978 | 18,794,978,000 | 175,368 | 17,536,800 | 1071.75 | 1.47 |
| 2001 | 19,614,367 | 19,614,367,000 | 175,400 | 17,540,000 | 1118.26 | 1.50 |
| 2002 | 19,462,900 | 19,462,900,000 | 172,977 | 17,297,700 | 1125.17 | 1.87 |
| 2003 | 20,520,700 | 20,520,700,000 | 171,634 | 17,163,400 | 1195.61 | 1.90 |
| 2004 | 20,492,900 | 20,492,900,000 | 167,056 | 16,705,600 | 1226.71 | 1.81 |
| 2005 | 19,582,600 | 19,582,600,000 | 165,115 | 16,511,500 | 1186.00 | 1.61 |
| 2006 | 20,247,000 | 20,247,000,000 | 160,341 | 16,034,100 | 1262.75 | 1.92 |
| 2007 | 19,975,100 | 19,975,100,000 | 161,780 | 16,178,000 | 1234.71 | 1.72 |
| 2008 | 17,371,900 | 17,371,900,000 | 163,661 | 16,366,100 | 1061.46 | 2.22 |
| 2009 | 17,794,000 | 17,794,000,000 | 162,751 | 16,275,100 | 1093.33 | 2.11 |

Note: Source: Food and Agriculture Organization of the United Nations.

Table 5

*Data sources – Technology, Agricultural Machinery*

| Year | United States Tractors | Tractors per 100 $km^2$ of Arable Land | Mexico Tractors | Tractors per 100 km2 of Arable Land | U.S./ Mexico Ratio |
|---|---|---|---|---|---|
| 1980 | 4,726,000 | 250.3774734 | 115,057 | 50.02478261 | 5.01 |

Table 5 (continued).

| Year | United States Tractors | Tractors per 100 $km^2$ of Arable Land | Mexico Tractors | Tractors per 100 km2 of Arable Land | U.S./ Mexico Ratio |
|---|---|---|---|---|---|
| 1981 | 4,697,000 | 248.8410903 | 143,078 | 62.07288503 | 4.01 |
| 1982 | 4,669,000 | 248.6618912 | 146,083 | 63.13553462 | 3.94 |
| 1983 | 4,671,000 | 248.7684073 | 152,319 | 65.83066816 | 3.78 |
| 1984 | 4,676,000 | 249.0346976 | 155,000 | 66.98936814 | 3.72 |
| 1985 | 4,670,000 | 248.7151493 | 178,571 | 76.63991416 | 3.25 |
| 1986 | 4,730,000 | 251.910633 | 202,141 | 86.01744681 | 2.93 |
| 1987 | 4,789,000 | 257.8307545 | 225,712 | 95.2371308 | 2.71 |
| 1988 | 4,548,492 | 244.882256 | 250,000 | 104.6025105 | 2.34 |
| 1989 | 4,487,595 | 241.6244898 | 272,900 | 113.2365145 | 2.13 |
| 1990 | 4,426,699 | 238.4098645 | 300,000 | 123.4567901 | 1.93 |
| 1991 | 4,365,802 | 235.1301191 | 317,313 | 129.7803681 | 1.81 |
| 1992 | 4,304,906 | 233.8606041 | 312,408 | 126.995122 | 1.84 |
| 1993 | 4,317,974 | 236.2802329 | 307,503 | 123.9931452 | 1.91 |
| 1994 | 4,331,042 | 238.0491264 | 302,597 | 121.5248996 | 1.96 |
| 1995 | 4,344,109 | 238.8986411 | 297,692 | 118.6023904 | 2.01 |
| 1996 | 4,357,177 | 243.4095505 | 292,787 | 117.114800 | 2.08 |
| 1997 | 4,370,245 | 246.0834384 | 287,882 | 115.152800 | 2.14 |
| 1998 | 4,414,705 | 249.7259336 | 282,977 | 112.7398406 | 2.22 |

Table 5 (continued).

| Year | United States Tractors | Tractors per 100 $km^2$ of Arable Land | Mexico Tractors | Tractors per 100 km2 of Arable Land | U.S./ Mexico Ratio |
|---|---|---|---|---|---|
| 1999 | 4,459,165 | 254.2747251 | 278,072 | 110.7856574 | 2.30 |
| 2000 | 4,503,625 | 256.8099653 | 273,166 | 108.8310757 | 2.36 |
| 2001 | 4,548,085 | 259.2978905 | 268,261 | 106.8768924 | 2.43 |
| 2002 | 4,592,545 | 265.5003266 | 263,356 | 104.9227092 | 2.53 |
| 2003 | 4,551,998 | 265.2154002 | 258,451 | 102.9685259 | 2.58 |
| 2004 | 4,511,452 | 270.0562686 | 253,546 | 101.0143426 | 2.67 |
| 2005 | 4,470,905 | 270.7752173 | 248,640 | 99.456000 | 2.72 |
| 2006 | 4,430,359 | 276.3085549 | 243,735 | 99.48367347 | 2.78 |
| 2007 | 4,389,812 | 271.344542 | 238,830 | 97.66899767 | 2.78 |

Note: Source: The World Bank – Global Development Finance Database.

PS is the ratio of the Producer Support Estimate subsidies between the United States and Mexico (Table 6), GS is the ratio of the General Services Support Estimate subsidies between the United States and Mexico (Table 6), and CS is the ratio of United States/Mexico Consumer Support subsidies (Table 6).

Table 6

*Data sources – Subsidies*

| Year | Mexico PSE USDmn | U.S. PSE USDmn | PSE Ratio | Mexico GSSE USDmn | U.S. GSSE USDmn | GSSE Ratio | Mexico CSE USDmn | U.S. CSE USDmn | CSE Ratio |
|---|---|---|---|---|---|---|---|---|---|
| 1986 | 550 | 38,019 | 69.15 | 999 | 13,481 | 13.50 | 781 | (4,167) | (5.34) |
| 1987 | 1,077 | 39,118 | 36.32 | 542 | 13,387 | 24.71 | 346 | (6,076) | (17.56) |
| 1988 | (90) | 31,520 | (349.10) | 499 | 14,179 | 28.42 | 1,602 | (1,140) | (0.71) |
| 1989 | 2,574 | 38,637 | 15.01 | 695 | 15,456 | 22.25 | (850) | (9,635) | 11.33 |
| 1990 | 4,303 | 31,265 | 7.27 | 1,270 | 16,856 | 13.27 | (3,078) | (1,044) | 0.34 |
| 1991 | 7,528 | 30,734 | 4.08 | 905 | 20,963 | 23.15 | (5,803) | (560) | 0.10 |
| 1992 | 8,300 | 31,585 | 3.81 | 1,102 | 24,199 | 21.96 | (6,101) | 1,372 | (0.22) |
| 1993 | 9,484 | 33,819 | 3.57 | 1,308 | 26,456 | 20.23 | (6,990) | 587 | (0.08) |
| 1994 | 7,005 | 29,059 | 4.15 | 1,167 | 28,047 | 24.02 | (3,310) | 2,485 | (0.75) |
| 1995 | (1,059) | 20,423 | (19.28) | 551 | 27,216 | 49.37 | 2,440 | 7,383 | 3.03 |
| 1996 | 1,541 | 29,161 | 18.92 | 541 | 25,564 | 47.26 | 203 | 2,840 | 14.00 |
| 1997 | 4,285 | 30,258 | 7.06 | 371 | 24,253 | 65.43 | (2,460) | 3,133 | (1.27) |
| 1998 | 5,191 | 46,485 | 8.96 | 417 | 22,629 | 54.26 | (3,479) | (5,059) | 1.45 |
| 1999 | 5,246 | 55,746 | 10.63 | 508 | 22,520 | 44.30 | (3,911) | (4,684) | 1.20 |
| 2000 | 7,397 | 52,278 | 7.07 | 628 | 22,382 | 35.61 | (5,416) | (466) | 0.09 |
| 2001 | 6,484 | 51,040 | 7.87 | 649 | 24,141 | 37.19 | (4,238) | (1,236) | 0.29 |
| 2002 | 9,227 | 40,335 | 4.37 | 629 | 26,944 | 42.82 | (7,088) | 3,823 | (0.54) |
| 2003 | 6,610 | 36,091 | 5.46 | 878 | 30,696 | 34.94 | (4,023) | 9,863 | (2.45) |

Table 6 (continued).

| Year | Mexico PSE USDmn | U.S. PSE USDmn | PSE Ratio | Mexico GSSE USDmn | U.S. GSSE USDmn | GSSE Ratio | Mexico CSE USDmn | U.S. CSE USDmn | CSE Ratio |
|---|---|---|---|---|---|---|---|---|---|
| 2004 | 4,260 | 43,254 | 10.15 | 823 | 32,850 | 39.90 | (1,769) | 9,100 | (5.14) |
| 2005 | 5,007 | 40,629 | 8.11 | 815 | 35,830 | 43.97 | (1,776) | 14,474 | (8.15) |
| 2006 | 5,572 | 30,561 | 5.48 | 775 | 38,399 | 49.55 | (1,780) | 20,372 | (11.44) |
| 2007 | 6,119 | 33,203 | 5.43 | 982 | 37,809 | 38.52 | (1,865) | 12,172 | (6.53) |
| 2008 | 6,320 | 27,043 | 4.28 | 835 | 45,088 | 53.98 | (921) | 27,129 | (29.47) |
| 2009 | 5,821 | 30,598 | 5.26 | 764 | 56,651 | 74.17 | (1,760) | 28,631 | (16.26) |

Note: Source: Organization for Economic Co-operation and Development.

As these ratios (Table 7) increase the research hypothesis is that there is an increase in a negative trade balance in corn for Mexico.

Table 7

*Data sources – Regression Data*

| Year | Maize Imports (1,000) Metric Tons | U.S. /Mexico Production Ratio | U.S. /Mexico Efficiency Ratio | U.S. /Mexico Fertilizer Ratio | U.S. /Mexico Tractor Ratio | U.S. /Mexico PSE Ratio | U.S. /Mexico GSSE Ratio | U.S. /Mexico CSE Ratio |
|---|---|---|---|---|---|---|---|---|
| 1986 | 1,703.58 | 20.89 | 4.49 | 1.20 | 2.93 | 69.15 | 13.50 | -5.34 |
| 1987 | 3,602.90 | 18.30 | 4.56 | 1.20 | 2.71 | 36.32 | 24.71 | -17.56 |
| 1988 | 3,301.83 | 12.40 | 3.16 | 1.30 | 2.34 | (349.10) | 28.42 | -0.71 |

Table 7 (continued).

| Year | Maize Imports (1,000) Metric Tons | U.S. /Mexico Production Ratio | U.S. /Mexico Efficiency Ratio | U.S. /Mexico Fertilizer Ratio | U.S. /Mexico Tractor Ratio | U.S. /Mexico PSE Ratio | U.S. /Mexico GSSE Ratio | U.S. /Mexico CSE Ratio |
|---|---|---|---|---|---|---|---|---|
| 1989 | 4,856.05 | 19.62 | 4.35 | 1.40 | 2.13 | 15.01 | 22.25 | 11.33 |
| 1990 | 2,028.08 | 14.29 | 3.48 | 1.35 | 1.93 | 7.27 | 13.27 | 0.34 |
| 1991 | 918.79 | 12.93 | 3.25 | 1.53 | 1.81 | 4.08 | 23.15 | 0.10 |
| 1992 | 520.98 | 12.92 | 3.34 | 1.57 | 1.84 | 3.81 | 21.96 | -0.22 |
| 1993 | 1,479.55 | 8.35 | 2.54 | 1.73 | 1.91 | 3.57 | 20.23 | -0.08 |
| 1994 | 3,001.74 | 15.02 | 4.10 | 1.60 | 1.96 | 4.15 | 24.02 | -0.75 |
| 1995 | 6,477.19 | 10.57 | 3.11 | 2.15 | 2.01 | (19.28) | 49.37 | 3.03 |
| 1996 | 3,161.57 | 12.39 | 3.47 | 1.73 | 2.08 | 18.92 | 47.26 | 14.00 |
| 1997 | 4,126.88 | 13.47 | 3.30 | 1.73 | 2.14 | 7.06 | 65.43 | -1.27 |
| 1998 | 5,453.89 | 13.93 | 3.73 | 1.56 | 2.22 | 8.96 | 54.26 | 1.45 |
| 1999 | 4,804.24 | 12.45 | 3.16 | 1.58 | 2.30 | 10.63 | 44.30 | 1.20 |
| 2000 | 5,944.55 | 14.06 | 3.42 | 1.47 | 2.36 | 7.07 | 35.61 | 0.09 |
| 2001 | 4,517.34 | 11.83 | 3.31 | 1.50 | 2.43 | 7.87 | 37.19 | 0.29 |
| 2002 | 5,288.34 | 11.81 | 2.96 | 1.87 | 2.53 | 4.37 | 42.82 | -0.54 |
| 2003 | 5,682.53 | 11.75 | 3.15 | 1.90 | 2.58 | 5.46 | 34.94 | -2.45 |
| 2004 | 5,885.48 | 13.60 | 3.51 | 1.81 | 2.67 | 10.15 | 39.90 | -5.14 |
| 2005 | 6,335.94 | 14.48 | 3.16 | 1.61 | 2.72 | 8.11 | 43.97 | -8.15 |
| 2006 | 8,767.87 | 11.97 | 3.09 | 1.92 | 2.78 | 5.48 | 49.55 | -11.44 |

Table 7 (continued).

| Year | Maize Imports (1,000) Metric Tons | U.S. /Mexico Production Ratio | U.S. /Mexico Efficiency Ratio | U.S. /Mexico Fertilizer Ratio | U.S. /Mexico Tractor Ratio | U.S. /Mexico PSE Ratio | U.S. /Mexico GSSE Ratio | U.S. /Mexico CSE Ratio |
|---|---|---|---|---|---|---|---|---|
| 2007 | 9,817.61 | 14.03 | 2.94 | 1.72 | 2.78 | 5.43 | 38.52 | -6.53 |

Findings

The regression model for these variables shows a high level of significance of .0059 with R-square and adjusted R-square values of .7079 and .5618 respectively (Table 8).

Table 8

*Regression Output*

| Source | SS | df | MS | | | |
|---|---|---|---|---|---|---|
| | | | | Number of obs | = | 22 |
| | | | | F( 7, 14) | = | 4.85 |
| Model | 84217722.6 | 7 | 12031103.2 | Prob > F | = | 0.0059 |
| Residual | 34756962.6 | 14 | 2482640.18 | R-squared | = | 0.7079 |
| | | | | Adj R-squared | = | 0.5618 |
| Total | 118974685 | 21 | 5665461.2 | Root MSE | = | 1575.6 |

| Imports | Coef. | Std. Err. | t | P> t | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| Production | 435.1176 | 364.7258 | 1.19 | 0.253 | -347.1415 | 1217.377 |
| Efficiency | -1588.243 | 1648.545 | -0.96 | 0.352 | -5124.022 | 1947.535 |

Table 8 (continued).

| Imports | Coef. | Std. Err. | t | P> t | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| Fertilizer | 4603.403 | 2553.782 | 1.80 | 0.093 | -873.9151 | 10080.72 |
| Tractors | 3059.115 | 1634.436 | 1.87 | 0.082 | -446.4015 | 6564.631 |
| PSE | -3.528154 | 5.180063 | -0.68 | 0.507 | -14.63828 | 7.581976 |
| GSSE | 55.41359 | 32.79305 | 1.69 | 0.113 | -14.92051 | 125.7477 |
| CSE | .7624109 | 71.50022 | 0.01 | 0.992 | -152.5903 | 154.1151 |
| Constant | -12555.83 | 6493.849 | -1.93 | 0.074 | -26483.75 | 1372.092 |

The p-values for the independent variables are significant for two variables and marginally significant for another; the one-tail p-value for the United States/Mexico ratio of tractors per 100 square kilometers of arable land is .041 with a coefficient of 3059, United States/Mexico ratio of fertilizer consumption per hectare of arable land is .0465 with a coefficient of 4603, and the United States/Mexico ratio of General Services Support Estimate (GSSE) at .0565 and with a coefficient of 55. The null hypotheses for these three independent variables are rejected.

As the United States/Mexico ratio of tractors per 100 square kilometers of arable land increases by one, Mexican imports of corn from the United States, as indicated by the coefficient, increase by 3,059,115 metric tons. The average number of tractors per 100 square kilometers during the period studied is 252 in the United States and 110 in Mexico. A change in this tractor ratio by one requires an increase of the number of tractors in Mexico by 77.3 percent or 85 more tractors per 100 square kilometers. This predicts a reduction of corn imports from the United States by 3,059,155 metric tons per year. A decrease of 30 percent or 33 tractors per 100 square kilometers in Mexico will also result in this magnitude of change, increasing the corn imports by 3,059,155 metric tons per year. These results indicate that over the 22 years in this study there is strong predictability between use of agricultural equipment in Mexico and the rate of importation of corn into Mexico from the United States.

As the United States/Mexico ratio of fertilizer per hectare of arable land increases by one, as indicated by the coefficient, Mexican imports of corn from the United States increase by 4,603,403 metric tons or approximately one half of the average imports per year over the period studied. The average kilograms of fertilizer per hectare of arable land consumed during the period studied is 1,095 in the United States and 688 in Mexico. A 168 percent increase or 1,162 more kilograms of fertilizer per hectare in Mexico will result in this magnitude of change, decreasing Mexican imports of corn from the United States by 4,603,403 metric tons per year. Likewise, a 38.5 percent decrease in fertilizer use in Mexico of 265 kilograms per hectare predicts a corresponding increase in Mexican imports of corn from the United States of 4,603,403 metric tons annually.

As the United States/Mexico ratio of GSSE increase by one, as indicated by the coefficient, imports of corn increase by 55,140 metric tons. This ratio averages 7.33 per year throughout the period studied, with United States averaging 36.286 billion USD per year and Mexico 4.948 billion USD. An increase of United States GSSE expenditure of 4.948 billion USD, or a decrease of Mexican GSSE expenditure of .5937 billion USD results in an increase of this ratio by one, reflecting an increase of imports of 55,140 metric tons annually. Also, a decrease of United States GSSE expenditure of 4.948 billion USD or an increase of Mexican GSSE expenditure of .781 billion USD results in a decrease of this ratio by one, reflecting a decrease of imports of 55,140 metric tons annually. Although GSSE has a marginal 1-tail p-value of .0565, corn exports of 55,140 metric tons to Mexico is not a meaningful coefficient.

The rest of the independent variables have p-values with much less significance. The 1-tail p-values for these variables include .1265 for the production ratio, .176 for the production efficiency ratio, .2535 for the Producer Support Estimate (PSE) subsidy ratio, and .496 for the Consumer Support Estimate (CSE) subsidy ratio. These United States/Mexico ratios do not predict the dependent variable of tonnage of United States exports of corn to Mexico.

The null hypothesis cannot be rejected for production or efficiency ratios, Producer Support Estimate (PSE) subsidies, or for Consumer Support Estimate (CSE) subsidies, but is rejected for the technology input ratios (fertilizer consumption and farm equipment use) and General Services Support Estimate (GSSE) subsidies. Changes to ratios of farm equipment use, fertilizer consumption, and General Services Support Estimate (GSSE) subsidies do predict changes in United States exports of corn to Mexico.

## Analysis

The purpose of this model is to demonstrate the effects of government subsidies, national production levels, and the application of technology on the quantity of net imports of corn into Mexico from the United States.  The data provides a sample size of 22 observed years.  The time-series model satisfies the assumptions of the classical linear regression model; the data is linear in its parameters, there is no perfect collinearity among the independent variables, it possesses a zero conditional mean for each year, the data is homoscedastic, there is no serial correlation between time periods, and the errors of the independent variables are normally distributed.

The model's residual plots, residual-versus-predictor (Figures 1-7) indicate the independent variables of the model follow a random pattern, indicating a good fit of the data for linear regression analysis. The data are neither non-random U-shaped, non-random inverted U-shaped, nor trending. None of the independent variables are constants, or a perfect linear combination of others. The model has relatively small residual with an F statistic of .0059, indicating that for each observation the expected value of the error is zero. These evidences provide that the estimators are unbiased indicators of the model; the ordinary least squares (OLS) of this model are unbiased.

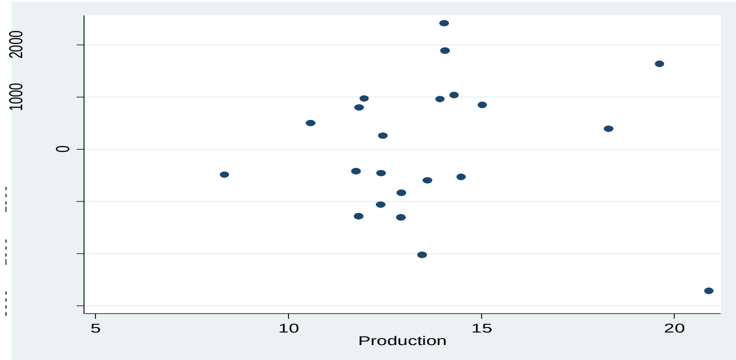


*Figure 1*. Residuals for the independent variable production.

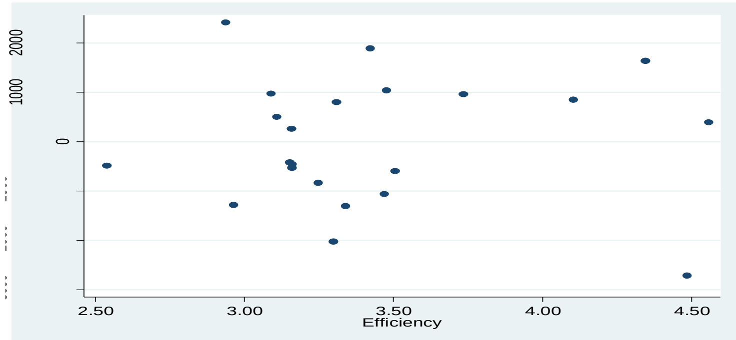


*Figure 2*. Residuals for the independent variable efficiency.

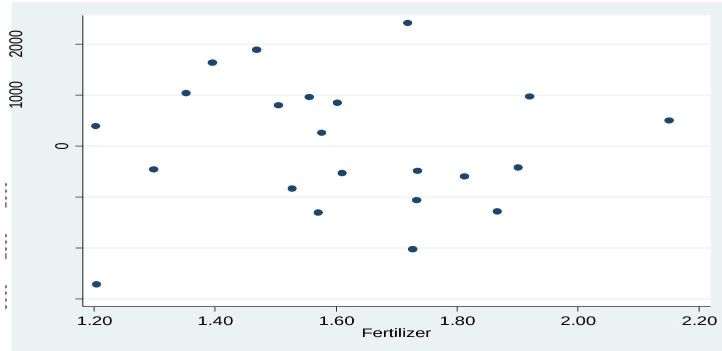


*Figure 3*. Residuals for the independent variable fertilizer.

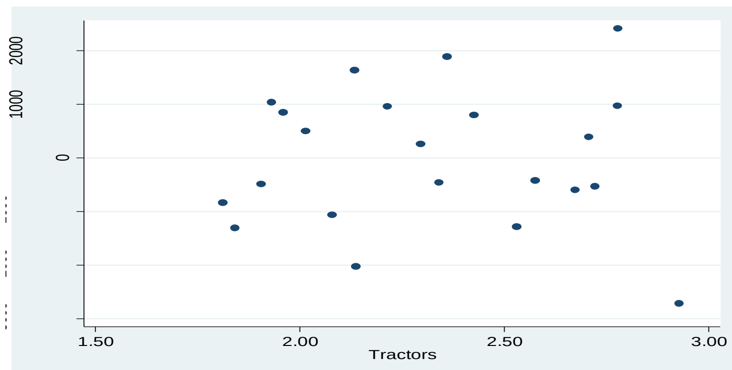


*Figure 4*. Residuals for the independent variable tractors.

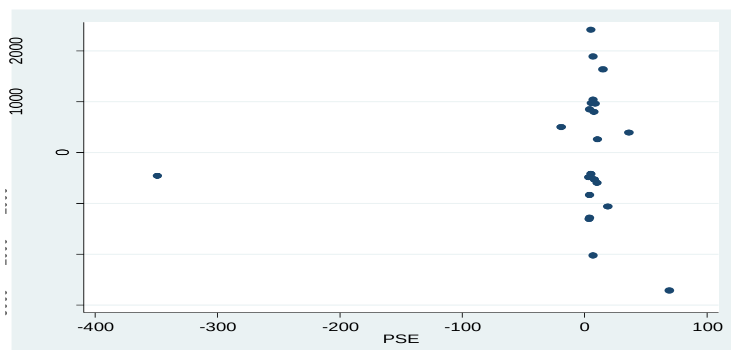


*Figure 5*. Residuals for the independent variable Producer Support Estimate Subsidy (PSE).

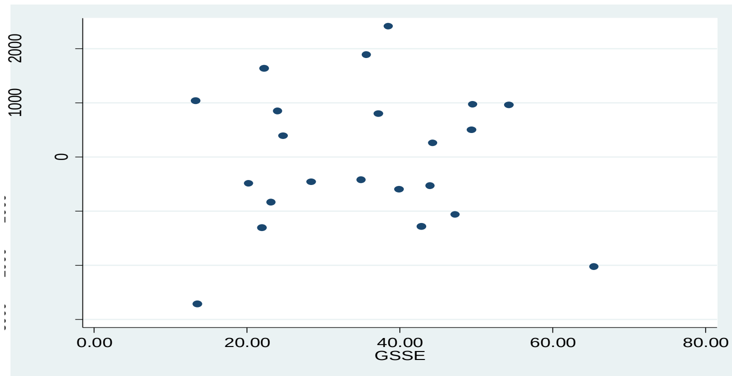


*Figure 6*. Residuals for the independent variable General Services Support Estimate Subsidy (GSSE).

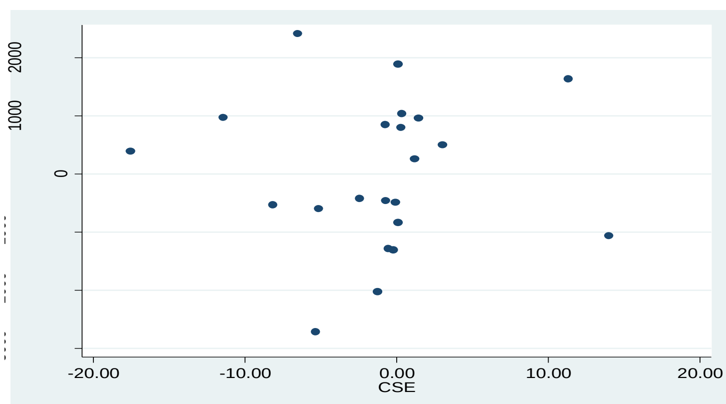


*Figure 7*. Residuals for the independent variable Consumer Support Estimate Subsidy (CSE).

The model's residual plots also demonstrate a variance of the errors and so demonstrate that the model is homoscedastic. The unobserved variables affecting the dependent variable have a constant variance over time. The errors in different time periods are also uncorrelated; there is no serial correlation. Durbin-Watson test of the model reveals Durbin-Watson Statistic D values, for the independent variables with significant p-values, between the lower critical value $D_L$ and the upper critical value $D_U$ indicating inability to determine autocorrelation of this data set with the Durbin-Watson test (Table 9).

Table 9

*Durbin-Watson Statistic Values*

| Model, IV | k | n | D | DW table used | DL | DU |
|---|---|---|---|---|---|---|
| Fertilizer | 8 | 22 | 1.366926 | 5% | 0.863 | 1.940 |
| Tractors | 8 | 22 | 1.366926 | 5% | 0.863 | 1.940 |
| GSSE | 8 | 22 | 1.366926 | 5% | 0.863 | 1.940 |

Given that these data satisfy the five assumptions of a time-series model the OLS estimators (Gauss-Markov theorem) they are the best linear unbiased estimates (BLUE) of the variables in this model. The errors for each time period are independent of the causal variables and are distributed in a normal distribution (Wooldridge 2006, 352, 354). Since this model fits the classic linear regression model assumptions, we can accept that the causal variables in this model affect the response variable of imported corn from the United States into Mexico.

Goodness of fit for this model also explains the variance of the coefficient of determination (R-square) and adjusted R-square, which are .7079 and .5618, respectively. The adjusted R-square compensates for lost degrees of freedom by reducing the explained variance of the model for each additional independent variable. Although a longer time-series is desired, this data set provides the available and most consistent data set for this study. The independent variables in this model account for over 56 percent of the variation in the model, and the calculated F statistic for the model of .0059 indicates that the probability of this influence by the independent variables occurring solely by chance is remote. This provides confidence that the model is accounting for significant changes in corn trade balance between the United States and Mexico.

Three independent variables provide p-values that indicate significant probabilities. The residual plots for these independent variables (Figures 1-7) reveal random patterns confirming the randomness and homoscedasticity of the data. The findings of this model are consistent with other research and established trade theory, as Bulmer-Thomas (2003) describes the propensity of the organizational infrastructures of industrialized countries overwhelming competition from lesser developed countries, and Bhagwati's describes the implementation of the "aggressive unilateralism" of strong economies against weaker competitors (Bhagwati 1994, 231).

Ratio of farm equipment in the United States and Mexico using as a proxy the number of tractors per 100 square kilometers of arable land has a 2-tailed test value of .082, a 1-tailed .041 p-value to predict negative trade balances of corn in Mexico with the United States. The coefficient of 3059.115 indicates that with this high degree of certainty (p-value) a change in unity of the United States/Mexico tractor ratio per 100 square kilometers predicts an increase of this unbalanced corn trade by a factor of one-third of the average tonnage per year over the period studied. The ratio of consumed fertilizer per hectare of arable land in the United States and Mexico has a 2-tailed test value of .093 and a 1-tailed 0.0465 p-value to predict negative trade balances of corn in Mexico with the United States. The coefficient of 4603.403 indicates that with this high degree of certainty (p-value) a change in unity of the United States/Mexico fertilizer consumption ratio per hectare of arable land predicts an increase of this unbalanced corn trade by a factor of one half of the annual corn trade per year over the period studied.

The ratio of General Services Support Estimate (GSSE) in the United States and Mexico has a 2-tailed test value of .113, for this measure a 1-tailed 0.056 p-value to predict negative trade balances of corn by Mexico with the United States. The coefficient of 55.41359 indicates that with this moderate degree of certainty (p-value) a change in unity of the United States/Mexico GSSE expenditure results in an increase of this unbalanced annual corn trade by 55,414 metric tons annually.

The independent variables in this model are ratios of national quantities of the United States and Mexico. Yield (L) and fertilizer (F) are compared per hectare. This model demonstrates that as the ratios of the United States/Mexico domestic farm equipment use, fertilizer consumption, and General Service Support subsidies increase the Mexican imports of United States corn from 1986 through 2007 increased. The null hypotheses for these data are rejected. There are strong probabilities with measurable coefficients that increasing the United States/Mexico ratios of farm equipment use and fertilizer consumption increase corn imports to Mexico from the United States. The United States/Mexico GSSE ratio demonstrates in this model, a moderate probability, and with measured coefficients, that increases in the United States/Mexico GSSE ratio of domestic expenditure predicts a moderate, but measureable, increase in unbalanced trade in corn in Mexico with the United States.

What is most surprising from this study is that Producer Support Estimates; payments to the farmers, and Consumer Support Estimates, government support of market consumption, are not significant in this model. Others, such as Burstein (2007) advocate that subsidies paid to United States farmers (producers) directly affect the costs and prices of the supply chain of corn and its delivery to Mexico. This claim is not borne out by this model. The findings of this model are that direct producer subsidies and consumer market subsidies are not found to affect the corn trade balance of the United States and Mexico, that PSE and CSE subsidies may not have implications for trade with Mexico, while GSSE does.

Additionally, it is surprising that neither quantity of production as a ratio between the United States and Mexico, nor the yield ratio between these two countries possesses statistical significance with respect to unbalanced trade in corn in this model and, hence, provides no predictive power of Mexican corn imports from the United States. The null hypothesis is not rejected. These three measures of agricultural inputs in this model show no relation to the quantity of Mexican corn imports. The application of this model to considerations of production, efficiency, PSE, and CSE is that none of these affect the corn trade balance of the United States and Mexico.

## Conclusions

Relative agricultural production, yield ratios, and producer and consumer government subsidies between the United States and Mexico appear to have no impact on the amount of Mexican corn imported from the United States. Government subsidies in the form of General Services Support Estimate (GSSE), however, do predict the size of United States corn exports to Mexico. Further, the findings of this model indicate that increases in mechanization in the Mexican farming sector and increases in inputs such as fertilizer consumption in Mexico significantly predict reduction in unbalanced corn trade between the United States and Mexico.

Policy implications for the United States government and subsequent legislative initiatives indicate that producer and consumer domestic subsidies do not have a predictive impact on corn trade with Mexico and that increases in general services support expenditures have only moderate predictive and quantitative impact on this trade. Contentions that individual domestic farm supports or consumer supports for food affect international trade with Mexico are not borne out by this study. Furthermore, for both national governments, these findings show that domestic mechanization and associated domestic producer efficiency remain the most significant enhancers of production with subsequent effect on international corn trade.

An economy's size does matter to national growth. These findings are consistent with Bhagwati's (1994, 231) insight and concern about the implementation of "aggressive multilateralism" of strong economies against weaker competitive nations, despite the tendency of international trade to increase the individual and public wealth of trading nations, in an effect described as a "lifting-all-boats" of the economies involved in that trade (Bhagwati 1994, 242). Bulmer-Thomas' (2003) hypothesis also predicts that especially in technical productive capacity the organizational infrastructures of the most industrialized countries overwhelm lesser developed ones.

# CHAPTER III

# THE EFFECT OF MEXICAN CORN IMPORTS AND MEXICAN AGRICULTURAL SUBSIDIES ON THE ECONOMIC CONDITIONS OF THE MEXICAN RURAL POOR

## Introduction

Unbalanced feed grain trade, especially corn, between the United States and Mexico, under the North American Free Trade Agreement (NAFTA) is said to adversely affect the welfare of rural Mexico (Burstein 2007). Modern economic theory accepts the welfare enhancing effects of free trade (Stiglitz and Charlton 2005, 12), but free trade agreements do not always increase everyone's welfare (Stiglitz and Charlton 2005, 28). During the first decade of free trade under NAFTA, economic growth in Mexico was slower than it had been prior to 1980, and the "mean real wages [in Mexico] at the end of the decade were lower, and some of the poorest had been made worse off as subsidized American agricultural products flooded the market and lowered the price received for Mexican domestic production. Inequality and poverty both increased under NAFTA" (Stiglitz and Charlton 2005, 23). Other poverty-inducing factors exist, the impact of which are analyzed in this chapter. Although Mexicans benefit from a cheaper consumption basket, this research investigates the effect of increasing Mexican imports of corn from the United States and the levels of Mexican agricultural subsidies on the welfare of the rural Mexican population.

## Review of the Literature

### *Theoretical Background*

Bhagwati, defending economic globalization and free trade, contends that countries with lower tariffs have higher rates of growth (Bhagwati 2004, 3). He shows that effects of free trade are welfare-enhancing for the poor (Bhagwati 2004, 60-64).

Less sanguine about the benefits of free trade, Stiglitz notes that there is no conclusive empirical evidence that trade liberalization leads to national economic growth (Stiglitz and Charlton 2005, 33). He also notes that different regions approach policies of integration, openness, and free trade differently (Stiglitz and Charlton 2005, 20). East Asia, for example, does not follow orthodox free trade prescriptions, but dual policies of import protection and export promotion (Stiglitz and Charlton 2005, 16). Srinivasan and Bhagwati (1999) note that free trade can contribute to reduced income and growth when market failures exist in an economy. A regime of free trade may not effectively contribute to a nation's success when it lacks institutional capacity and adequate investments in research and development to take advantage of market changes related to free trade (Stiglitz and Charlton 2005, 7, 30, 37, 89). Left alone, markets may not provide welfare-enhancing effects for a nation, and government intervention may be required to correct failures to make those markets work efficiently, as industries restructure and less skilled labor is eliminated (Stiglitz and Charlton 2005, 89). Agriculture, an example of a restructuring industry, is crucial to the economies of many developing countries with that sector accounting for as much as 40 percent of GDP and 70 percent of employment (Stiglitz and Charlton 2005, 120).

Bulmer-Thomas (2003, 16) documents that the role of tariffs in Latin America during the nineteenth century was to increase government revenue. Mexican trade policy evolved into import substitution from 1892 (Bulmer-Thomas 2003, 139) through 1989, when the Mexican National Development Plan was subsequently implemented by President Carlos Salinas de Gortari. A dramatic shift in economic policy occurred in Mexico following the 1982 debt crisis and resulted in the reluctant acceptance by Mexican authorities of a “New Economic Model (NEM) based on exports” that depended on a free trade regime (Bulmer-Thomas 2003, 353). Subsequent to implementation of this NEM the Mexican government did not implement public policies to protect those of its population most at risk in the shift of its economy to outward looking trade policies.

Bagwell and Staiger (2002, 169) use a partial equilibrium model to explain the political and economic motivations of governments implementing agricultural subsidies. Although governments seek, for political reasons, to help their exporters (Bagwell and Staiger 2002, 31), prices are constrained by market conditions (Bagwell and Staiger 2002, 170) and limit their action. Bagwell and Staiger note that since export-promoting governments seek to maximize profits less subsidy expenses, while in importing, a nation’s welfare is measured by consumer surplus, they predict that market inefficiencies result (Bagwell and Staiger 2002, 171). Preferential Trading Agreements (PTAs) are subject to negotiation and renegotiation of trade provisions and uncertain enforcement (Bagwell and Staiger 2002, 114). PTA implementation also involves lengthy transition timeframes (Bagwell and Staiger 2002, 116), allowing for competing voices in the political decision process and subsequently sub-optimal outcomes. These processes undermine the intent and limit the extent of implementation of a free trade regime.

Modern agricultural export subsidies have been a source of contention dating from at least the 1958 wheat flour case when "a GATT panel ruled against a French export subsidy," stating that it increased the French export market share against Australia (Bagwell and Staiger 2002, 164). In the 1980s, when a GATT panel ruled against the United States in favor of the European Community (Bagwell and Staiger 2002, 164) in a similar wheat flour case, the United States retaliated with an export subsidy, and the European Community subsequently responded in kind. This resulted in mounting subsidy war. A major goal of the Uruguay Round of trade negotiations conducted within the context of the General Agreement on Tariffs and Trade (GATT) in 1994 was agricultural trade reform, and GATT Article XVI was subsequently altered, reducing allowed agricultural export subsidies of developed nations. Debate occurred between the United States with the Cairns Group of nations, and between the European Union (EU) and net-food importing countries. The Cairns Group of nations was comprised Argentina, Australia, Brazil, Canada, Chile, Colombia, Fiji, Hungary, Indonesia, Malaysia, New Zealand, the Philippines, Thailand, and Uruguay. The United States and Cairns Group wanted agricultural subsidies phased out, and the European Union (EU) and net-food importing countries wanted agricultural subsidies to remain in place (Bagwell and Staiger 2002, 164). The unbalanced trade in feed grains, due to the domestic United States agricultural subsidies, is said to have resulted in the loss of agricultural employment in Mexico (Burstein 2007). Hanson (2007, 418), in the context of describing how globalization affects labor markets, notes a change in income distribution in the 1990s and lower levels of income for the Mexican poor. Nicita's (2004) analysis of tariff reductions from 1989 to 2000, especially in light of United States agricultural subsidies, determined that those tariff reductions adversely affected rural Mexican income.

*Effect on the Population*

Emmott (2003), Bacon (2008), Fayyaz (2008), and Zermeno (2008) note Mexican policies under free trade that negatively affect the rural poor. The Oxfam Report (2003) describes the Mexican corn sector being in acute crisis, stating, United States agricultural policy is directly linked to rural misery in Mexico and that surging imports have been associated with a steep decline in prices. Nicita (2004, 1) found that from 1989 to 2000 domestic prices of most non-animal agricultural products fell as free trade was introduced to Mexico, resulting in lower agricultural household income. Although Mexican households benefited from lower consumption basket prices, the downward pressure on unskilled wages, found in higher concentrations in rural Mexico, hurt low-income families more than affluent households.

Hanson (2003, 1) notes that 1980s Mexican trade policy reforms and the 1994 adoption of NAFTA changed Mexico's wage structure, which included increased demand for high-skilled workers. This occurred even though, as Hanson notes, "trade theory predicts that convergence in goods' prices between countries creates pressure for convergence in factor prices. In Mexico, this [affects] both wage levels and the relative wages of low- and high-skilled labor" (Hanson 2003, 2). Mexico's trade policy reforms, however, raised the skill premium, a negative effect on an economy with comparatively less high-skilled workers, and at the same time reduced industry rents going to labor (Hanson 2003, 3). Though outcomes differ depending on industry and whether it is more closely aligned to imports or exports, Stopler and Samuelson (1941, 62) note that most admit the possibility of a decline in the relative share of a large factor of production such as labor as a result of free trade; many even admit the possibility of a decline in the real income of a large factor of production. After demonstrating advantages of free trade for an economy, Stopler and Samuelson conclude that "if effects on the terms of trade can be disregarded, it has been shown that the harm which free trade inflicts upon one factor of production is necessarily less than the gain to the other. Hence, it is always possible to bribe the suffering factor by subsidy or other redistributive devices so as to leave all factors better off as a result of trade" (Stopler and Samuelson 1941, 73), and so indicate, among other things, that rural labor safety nets should remain in place with the implementation of a free trade regime such as NAFTA. Social safety programs did exist during the NAFTA implementation, but in phases and with changing policy intent (Esquivel 2010, 4). Hanson (2003, 3) also found that from 1990 to 2000 the wages of higher skilled labor and labor in northern Mexican states grew, while labor income shrank among the less skilled and among laborers in the southernmost Mexican states. In addition to free trade reform, efforts to implement new economic approaches, and concurrent with Mexico's entry into NAFTA, Mexico privatized state-owned enterprises, deregulated entry restrictions in many industries, and used wage and price restraints (Hanson 2003, 4). These are policy responses to currency crises, especially in the early 1980s, bouts of high inflation, and severe macroeconomic contractions (Hanson 2003, 3). Hanson attributes much of the wage disruption in Mexico, following implementation of free trade regimes from 1985 forward, to the elimination of institutionalized wages guaranteed to lower skilled workers and, by implication, to the agricultural industry. He indicates that industries that enjoyed favorable government policy, industry subsidization, and subsequently subsidized wages "experienced relatively large reductions in wages and employment after trade reform" (Hanson 2003, 6). Arbache, Dickerson, and Green (2004) also show that expected outcomes of free trade on developing countries is varied and may not be as traditional theory suggests, that is; "not opposite of that in developed countries" (Arbache et al. 2004, 74).

Arbache, Dickerson, and Green (2004) contend that wage dispersion and the level of employment in increasing international trade have contributed to the increase in the dispersion of wages and unemployment.

Arbache, Dickerson, and Green (2004) state that

> the most immediate effect of trade [liberalization] is a reduction in the extent to which domestic manufacturers can operate in protected markets. The reduction or elimination of trade barriers and tariffs combine to turn any markets that were previously highly imperfect into markets that are now more contestable, and hence generate lower prices and reduced producer rents. To the extent that such rents were previously shared with employees, wages will also fall after trade [liberalization]" (2004 77).

*Effect on the Land*

The dominance of imported United States feed grain, especially maize into Mexico, changes agriculture and land uses. Keleman, Hellin, and Bellon (2009, 52) document that changes in economic policies related to free trade affect key social systems that generate and maintain maize landraces in Chiapas, Mexico. In this context landraces are indigenous cultivated plants commonly grown during earlier periods in human history, but not used in large-scale modern agriculture. These policy changes relate to the implementation of free trade and include the "elimination and reorienting of agricultural subsidies, and changes to the channels through which farmers access technical assistance, credit and market information" (Keleman et al. 2009, 53). High production costs, coupled with low economic returns, make commercial maize farming less attractive for many small-scale farmers.

*Effect of the Free Trade Regime*

Nicita uses household survey data to derive the impact of Mexican trade liberalization on Mexican households by measuring "first-order (or impact) measurement effects in which the household cannot react to trade-liberalization price changes" (Nicita 2004, 2) and second order effects: "the effects of trade liberalization on household earnings" (Nicita 2004, 2). Nicita also notes that "geographically dispersed households will be affected differently by trade liberalization" (Nicita 2004, 2). Throughout the period from 1989 to 2000 domestic prices of most non-animal agricultural products fell as free trade was introduced to Mexico. This resulted in lower agricultural household income due to lower commodity prices. However, all of the Mexican households benefited from lower consumption basket prices. "Downward pressure on unskilled wages hurt labor supplied by low-income households," as the wealthy gained more than the poor and the northern states gained more real income than those states further south (Nicita 2004, 7, 30). Nicita (2004, 3, 27) finds that benefits of trade liberalization were disproportionately distributed to richer urban Mexican households. Northern Mexican states benefited from Maquiladora industries and proximity to labor opportunities in the United States.

Harrison (2007) notes that during the last two decades of the 20th century poverty rates dropped in developing countries as poor countries slashed protective tariffs and increased their participation in world trade. Ianchovichina, Nicita, and Soloaga (2001) use a computable general equilibrium model of the Mexican economy to generate prices in a simulation to predict the impact of a tariff reform on population welfare. They find that the "impact of tariff reform on welfare [to] be positive in general for all expenditure deciles with the poor individuals benefiting proportionately more than the rich" (Ianchovichina et al. 2001, 19). The real need of the poor Mexican farmers was to receive income support during the 1990s as the free trade regime was implemented, and during this period small farmers lost income and large corn farmers gained (Harrison 2007, 4). Poverty in Mexico increased between 1990 and 2000 (Harrison 2007, 17).

> Harrison (2007) chronicles the decline in corn commodity prices and the use of the Mexican national social safety net for farmers during the implementation of NAFTA, that
>
> during the 1990s, imports of both white and yellow corn increased, and prices of Mexican corn fell. The majority of the poorest corn farmers [are] net consumers of corn and hence benefit . . . from the drop in corn prices. The income from corn production among middle-income farmers, who are mostly net sellers, fell, both as a share of total income and in absolute terms. The decline in income from corn production among . . . net sellers would have translated into an equivalent decline in real income if farmer incomes had not been supplemented with transfers through government programs such as PROCAMPO and PROGRESA. (2007, 1)

Also, "evidence shows a clear link between export activity and poverty reduction in Colombia, Mexico, India, and Poland. This research suggests that efforts to dismantle barriers to developing-country exports" is beneficial to a nation (Harrison 2007, 27).

*Effect of Unbalanced Trade through Subsidies*

Export subsidies can be an attractive trading policy, providing cost advantages to domestic firms competing with similar export firms from other nations (Brander and Spencer 1985a, 83), and protecting the competitive markets of developing countries resulting in welfare benefits to the economy as a whole.  Export subsidies, however, are often the agricultural trading policy of developed nations. McMillan, Zwane, and Ashraf (2007, 183) state "Organization for Economic Cooperation and Development (OECD) countries sell their agricultural products on world markets at prices that are below the cost of production." These policies harm poor countries, most of whose poor are farmers, by depressing world commodity prices. Mexico liberalized its corn sector in the mid-1990s, with a subsequently "sharp decrease in the producer price of corn and an increase in Mexican corn imports from the United States" (McMillan et al. 2007, 185). Since the poorest of the Mexican farmers produce corn only for personal consumption, they are only indirectly affected by this reduction of corn prices. Medium sized Mexican farms are harmed while larger and commercial Mexican farming operations often receive transfer payments which offset market losses. The general population of developing countries does benefit from lower grain commodity prices (McMillan et al. 2007, 186). Findings indicate that 1) poorer countries are net importers of both cereals and food, 2) suppressed agricultural prices as a result of OECD subsidies benefit poor country consumers, and the poorest in these countries the most, 3) "NAFTA reduced the wedge between the real producer price and the border price, making corn production less profitable" (McMillan et al. 2007, 228), and 4) "the poorest corn farmers are net food buyers, since they have little land per person and so are forced to earn cash income in other ways in order to buy food" (McMillan et al. 2007, 228).

Aisbett (2007, 41) emphasizes the importance of "identifying the causal mechanisms through which globalization affects the poor" and how a free trade regime is implemented, which often affects the condition of the poor and subsequent political reaction (Aisbett 2007, 34). Free trade can be evaluated by assessing trade restriction levels or assessing a country's integration by measuring the flows of "goods, services, factors, and profits into and out of the country" (Aisbett 2007, 35). Subsidies are similar to tariffs, and so are inconsistent with free trade, with respect to the first measure. However, subsidies tend to increase integration of trade with the rest of the world and may be seen as consistent with free trade by this second measure.

Porto (2003) notes that studies on the relationship between trade and poverty in developing countries focus on the effects of national trade reforms, while WTO negotiations, especially as seen in the Doha Round, were more concerned with the poverty effects on low-income countries of foreign reforms, such as the elimination of agricultural subsidies in developed economies. Porto found that, in the case of Argentina participating in the MERCOSUR regional trade agreement (Porto 2003, 13), "national trade reforms have larger marginal effects than foreign trade reforms, [but] since there is greater room for foreign reforms, policy changes in developed countries . . . have, in the end, larger poverty impacts," and thus it is more important to the reduction of poverty for a country than its own policy reforms (Porto 2003, 1, 18).

*Summary*

Research has documented that unbalanced trade between the United States and Mexico has increased the standards of living of the general population of Mexico, while among the rural poor it may have increased poverty and inequality, increasing political discontent and less than optimal land use. New policies produce winners and losers, and these changes are consistent with Bhagwati (2004), and Stiglitz and Charlton's (2005) views of development. The implementation of free trade policies between the United States and Mexico began in the 1980s, and was fully implemented with NAFTA. The unintended consequences of subsidized products from the United States have an adverse impact on the small and medium sized rural agriculture in Mexico. Mexican government policies were less effective than needed in providing necessary safety nets for its rural population, especially during times of crisis such as the 1994-96 currency crisis.

## Theoretical Framework

Contention between those for and opposed to free trade have evolved to some extent because of the lack of connections made between "empirical findings and policy conclusions" (Aisbett 2007, 40). Reimer discusses "cross-country regression analyses, partial equilibrium/costs-of-living analyses, general equilibrium studies and micro-macro syntheses" as viable research methods to assess the impact of globalization (2002, 7). Aisbett adds to this list the need for "microeconomic studies that test specific mechanisms (other than prices) through which globalization is believed to impact the poor" (2007, 38).

Bagwell and Staiger (2002) demonstrate the theoretical basis of lost domestic productivity with unbalanced trade. The United States export market, although composed of producers in a perfectly competitive market, because of its advanced structure, is controlled by a smaller number of agricultural aggregator firms. This forms an imperfectly competitive (Cournot) market noted by Bagwell and Staiger (2002, 169), Brander (1995), and Helpman and Krugman (1989, 88). It is in this context of free trade under the NAFTA trade regime that continued United States domestic subsidies of feed grains, especially maize, is said to have subsequently contributed to a reduction in welfare in rural Mexico (Burstein, 2007). Although explanation of the effects of free trade within an imperfect market may allow for the use of strategic-trade theory espoused by Brander and Spencer (1985a, 1), the inclusive hybrid trade theory of Bagwell and Staiger provides a more comprehensive and versatile explanation of agricultural disputes

(2002, 169). A partial equilibrium model of trade exists in competitive markets. Although due to transportation costs feed grains from the United States predominate, this model demonstrates that prices in the importing market tend to be lower (Bagwell and Staiger 2002, 170) than local Mexican production.

Measurements of well-being and poverty are changing in the 21st century. Stiglitz, Sen, and Fitoussi (2009) contend that national income statistics, originally intended to measure market economic activity do not adequately measure societal well-being. They recommend focus on the median of the data used as being more reflective of general societal well-being than averages. They also remind us that a significant amount of economic activity occurs within the home. These approaches are reflected in Attanasio and Szekely's (2001, 6, 24, 33) discussion of poverty, adding to poverty measurement, personal assets, human capital, and redistribution effects. Szekely (2005, 927) and Esquivel (2010, 2) add inequality. The Mexican national Social Development policy Evaluation National Council (CONEVAL, 2009) data reflect these changing measures.

Hernandez and Szekely note in their work on poverty alleviation strategies for Mexico that limited information hampers use of statistical techniques "to determine the significance of the underlying relationships" between poverty and macroeconomic variables (2009, 36). They accept that their conclusions are limited and will be verified with more complete information and alternate statistical approaches. Each additional survey year provides data that improves the validity of findings. They note that, although it is necessary to obtain the longest possible time-series data on macroeconomic performance and on poverty levels, data is limited for Mexico. Similar to Szekely's (2005) approach this work extends the boundaries of previous research by evaluating the effects of causal variables on multiple definitions of rural Mexican welfare. These include measures of Mexican rural poverty from the World Bank, poverty headcount ratios from the Socio-Economic Database for Latin America and the Caribbean (SEDLAC), and the Consejo Nacional De Evaluacion de la Politica de Desarrolo Social (CONEVAL) estimates of poverty based on the Instituto Nacional de Estadistica y Geografia (ENIGH) data.

Hernandez and Szekely (2009, 37) use time-series poverty estimates constructed by Szekely (2005) for the years through 1989 and data from CONEVAL for 1992-2006 . Szekely (2005, 913) presents an “historical series of poverty and inequality in Mexico for the period 1950-2004,” but also relies on limited years of data collection throughout that period, seven surveys that include poverty assessment conducted between 1950 and 1977, and beginning in 1984 as the National Institute of Statistics, Geography and Informatics (INEGI) began to perform the National Survey of Income and Expenditure (ENIGH) on a biannual basis. Szekely (2005, 923) limits his analysis to only 15 points (years) of reliable data. Szekely (2005, 919) expands views of poverty from measuring only personal and household income to include measuring food poverty, or the inability to obtain the basic food basket, measuring capability poverty that includes access to medicine and education, and measuring poverty heritage that includes measuring limits on access to clothing, housing, and transportation. Szekely (2005, 927) is cautious about the robustness of his model predicting poverty and inequality in Mexico, and this due to the lack of access to household micro-data, the limited number of observations available and the potential effect of unknown variables over five decades. He finds, however, if the GINI coefficient is used as a proxy for Mexican population welfare, poverty and inequality are positively correlated from 1950 to 2004. Szekely also finds (2005, 928) poverty and inflation are positively correlated over the same period. Szekely maintains that inflation affects the poor most as they have less ability to protect their income and assets from steady increases in the price level. Szekely (2005, 923) finds that poverty declined between 1950 and 1984, remained flat between 1984 and 1994, increased through 1996, and then decreased through the balance of the period studied. Szekely (2005, 925) finds that inequality followed an inverted U Kuznets curve between 1950 and 1984, increased from 1984 and then reduced after 2000. CONEVAL also provides details of food poverty, capabilities poverty and heritage poverty for both rural and urban sectors, but only bi-annually from 1992. Esquivel (2010, 4) describes Mexican phases of growth to include social protection, including "non-targeted social programs (Solidaridad)" from 1982-1994, targeted programs in rural areas: Progresa and Procampo from 1994-2000, and Progresa expanding to urban areas from 2000-2006.

Hernandez and Szekely (2009, 39, 40) hold that recent poverty estimates are more accurate than older estimates. They find that policies that ensure economic growth, stabilize the economy and include social spending benefit the poor. Attanasio and Szekely (2001, 5) add that more than wages, assets affect poverty. These include personal physical capital of financial assets, property, and any other concrete forms of capital that can be used in production, and the social capital of interpersonal relationships and commitments of and to others within a cultural context. Szekely (2001, 241) describes changes in social policies in terms of generations of policies with different focuses and intended outcomes. Some have been built on the premise that economic growth enhances the welfare of the poor, but others have been established on the premise that the correlation between economic growth and increased welfare for the poor is less clear.

For this study CONEVAL provides poverty rates for 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2005, 2006, 2008 and 2010. Although CONEVAL collects an increasing amount of poverty data, it collects national and state data every two years and municipality data every five years as required by the General Law of Social Development (CONEVAL 2009). The inadequate amount of Mexican municipal data limits effective use of this information for time-series assessment at the municipal level. Other rural poverty data such as poverty headcount ratio at the rural poverty line from The World Bank and FGT poverty indicators (Foster, Greer, and Thorbecke 1984) from the Socio-Economic Database for Latin America and the Caribbean (SEDLAC) are used. These also are limited to data from 1989 and from even numbered years beginning with 1992.

Since much of the literature and especially Szekely (2001) and Esquivel (2010) note separate economic development phases in Mexico, and each with correspondingly different social programs and aid to the rural sector, composite measures of Mexican national government support are used. These include Producer Support Estimate (PSE) and the General Services Support Estimate (GSSE) and the with the Consumer Support Estimate (CSE) noted by the Organization for Economic Cooperation and Development (OECD) and are used to compare to composite effects on rural poverty

This research assesses the impact of Mexican governmental influence through subsidies on rural personal welfare quantified as proxies in three categories of Mexican agricultural subsidies and the external economic pressures on rural Mexico exerted by

Mexican imports of corn on measures of poverty. Poverty is measured as a percent of the population, relative poverty gaps, and poverty and inequality among the rural poor.

## Methodology

Personal rural welfare in Mexico, as noted by Stiglitz et al. (2009), Szekely (2005), and Esquivel (2010), and as prescribed by CONEVAL (2009) is assessed with different variables. This research assesses causal impact on sixteen separate measures of rural Mexican welfare. Szekely's choice of these measures is similar to decomposable poverty measures (FGT) proposed by Foster et al. (1984) and used by Socio-Economic Database for Latin America and the Caribbean (SEDLAC) and the World Bank. Foster et al. (1984) measure a simple headcount ratio, $FGT_0$, poverty gap, $FGT_1$, and a measure that combines poverty and income inequality among the poor, $FGT_2$. Twelve years of data are clearly identified for the twenty-two year period from 1989 to 2010.

This research evaluates independent variables using multiple linear regression models, each with different measures of Mexican rural welfare (dependent variable) to determine the effect of the independent variables on personal rural welfare. These are summarized in Table 10.

Table 10

*Poverty Indicator Summary*

| Source | Poverty Definition |
|---|---|
| World DataBank, World Development Indicators (WDI) and Global Development Finance (GDF) | |
| SI.POV.RUHC | Poverty Headcount Ratio at Rural Poverty Line (percent of Rural Population) |

Table 10 (continued).

| Source | Poverty Definition |
| --- | --- |

Socio-Economic Database for Latin America and the Caribbean (SEDLAC)

Poverty headcount ratios published by Latin American and Caribbean governments, and several individual poverty indicators computed following SEDLAC methodology, and using two international poverty lines: USD $2.50 and $4.00 per day at 2005 PPP. The USD $ 2.50 line coincides with the median of the extreme poverty lines chosen by the governments of the Latin American countries. The USD $ 4.00 line is similar to the median of the official moderate poverty lines. These are shown below.

USD 2.5 a Day Poverty Line
Rural Headcount FGT(0)
Poverty Gap FGT(1)
Poverty and Inequality FGT (2)

USD 4 a Day Poverty Line
Rural Headcount FGT(0)
Poverty Gap FGT(1)
Poverty and Inequality FGT (2)

Poverty Lines: 50 percent Median household per capita income
Rural Headcount FGT(0)
Poverty Gap FGT(1)
Poverty and Inequality FGT (2)

CONEVAL. Estimates of the CONEVAL with basis in the ENIGH from 1992 to 2010:

Rural Income Poverty by Person:

"Food poverty: Insufficient income to acquire the basic food basket, even if use is made of all the disposable income in the home exclusively for the purchase of these goods." (CONEVAL, 2010, under “Glossary”)

"Poverty of capabilities: Inadequate incomes to purchase the food basket and carry out the necessary expenditure on health and education, even if use is made of all the disposable income in the home exclusively for the purchase of these goods and services." (CONEVAL, 2010, under “Glossary”)

"Poverty of heritage: Inadequacy of the disposable income to purchase the food basket and carry out the necessary expenditure on health, education, clothing,

Table 10 (continued).

| Source | Poverty Definition |
|---|---|
| | housing and transportation, even if use is made of all the disposable income in the home exclusively for the purchase of these goods and services." (CONEVAL, 2010, under "Glossary") |
| | Rural Income Poverty by Household: |
| | "Food poverty: Insufficient income to acquire the basic food basket, even if use is made of all the disposable income in the home exclusively for the purchase of these goods." (CONEVAL, 2010, under "Glossary") |
| | "Poverty of capabilities: Inadequate incomes to purchase the food basket and carry out the necessary expenditure on health and education, even if use is made of all the disposable income in the home exclusively for the purchase of these goods and services." (CONEVAL, 2010, under "Glossary") |
| | "Poverty of heritage: Inadequacy of the disposable income to purchase the food basket and carry out the necessary expenditure on health, education, clothing, housing and transportation, even if use is made of all the disposable income in the home exclusively for the purchase of these goods and services." (CONEVAL, 2010, under "Glossary") |

The independent variables include four categories of data that may affect welfare. These include corn trade imbalances between the United States and Mexico measured as the annual tonnage of Mexican imports of corn from the United States, Mexican national government subsidies to producers per the Producer Support Estimate (PSE), general support of the Mexican agricultural sector per the General Services Support Estimate (GSSE), and Mexican consumer subsidies per the Consumer Support Estimate (CSE). The government support estimates summarize all forms of Mexican government agricultural support and provide a comprehensive and consistent summary of various aid programs implemented through stages of development in the Mexican economy noted by Esquivel (2010, 4). Throughout the literature and among data sources, reference to the quantity and significance of private investment in Mexican agricultural production, as seen in the ASTI database (Total Agricultural R and D Spending, Agricultural Science and Technology Indicators), is amazingly scarce.

The linear relationships for each of the measures of personal rural welfare are shown as:

$$Y = B_0 + B_1x_1 + \dots B_nx_{tn} + U_t$$

Such that, PRW = f (UFGT, PS, GS, CS), where PRW reflects sixteen separate measures of personal rural welfare in Mexico. UFGT is the tonnage of Mexican imports of corn from the United States. This data is from the United States Department of Agriculture, Foreign Agricultural Service. PS is Mexican Producer Support Subsidies (PSE), GS is Mexican General Services Support Subsidies (GSSE), and CS is Consumer Support Subsidies (CSE). These data are from the Organization for Economic Co-operation and Development (OECD).

Sixteen measures of personal rural welfare (PRW) are separately evaluated as the dependent variable in sixteen separate regressions. These separate regression models are used to broaden the perspectives of Mexican rural poverty and add to the validity of findings of this research over the twenty-two year period in this study. Mexican poverty headcount ratio at the rural poverty line, as a percent of the rural Mexican population; from the World Bank is one. Nine separate Foster, Greer, and Thorbecke (FGT) generalized measures of poverty are also evaluated. These are measures of the percent of the rural Mexican population and are drawn from the Socio-Economic Database for Latin America and the Caribbean (SEDLAC). Simple rural headcount ratio, $FGT_0$, the average rural poverty gap $FGT_1$, and the combined poverty and income inequality among the rural poor, $FGT_2$, are each assessed for three measures of rural poverty. They each include USD $2.50 a day rural poverty line (2005 PPP), USD $4.00 a day rural poverty line (2005 PPP), and 50 percent median rural household per capita income (2005 PPP). Szekely's (2005, 923) food poverty, capability poverty, and heritage poverty for individual rural and household rural income data are also assessed as dependent variables to isolate and confirm the effect of the independent variables on personal rural welfare. These data are also measures of the percent of the rural Mexican population and are drawn from the CONEVAL database. Each of these sixteen measures of personal rural welfare is treated as a dependent variable in regressions that span twelve, or in the case of CONEVAL data, eleven of the twenty-two years from 1989 to 2010, as shown in Table 11.

Table 11

*Poverty Regression Variable Data by Year*

| Personal Rural Welfare | 1989<br>2002 | 1992<br>2004 | 1994<br>2005 | 1996<br>2006 | 1998<br>2008 | 2000<br>2010 |
|---|---|---|---|---|---|---|
| Mexican rural poverty (percent of rural population) World Bank: | | | | | | |
| | | 66.5 | 69.3 | 80.7 | 75.9 | 69.2 |
| | 64.3 | 57.4 | 61.8 | 54.7 | 60.8 | 60.8 |
| USD 2.5 a Day Poverty Line SEDLAC: | | | | | | |
| Rural Headcount FGT(0) | 35.5 | 39.4 | 40.6 | 59.2 | 55.0 | 47.1 |
| | 39.3 | 32.5 | 30.3 | 24.9 | 30.2 | 27.8 |
| Poverty Gap FGT(1) | 14.8 | 15.2 | 16.0 | 28.3 | 24.9 | 20.1 |
| | 15.6 | 13.8 | 12.1 | 8.7 | 11.4 | 10.9 |
| Personal Rural Welfare | 1989 | 1992 | 1994 | 1996 | 1998 | 2000 |
| | 2002 | 2004 | 2005 | 2006 | 2008 | 2010 |

Table 11 (continued).

| Personal Rural Welfare | 1989<br>2002 | 1992<br>2004 | 1994<br>2005 | 1996<br>2006 | 1998<br>2008 | 2000<br>2010 |
|---|---|---|---|---|---|---|
| Poverty and Inequality FGT (2) | 8.7 | 7.9 | 8.6 | 17.7 | 14.6 | 11.5 |
| | 8.4 | 7.7 | 6.7 | 4.4 | 6.1 | 5.9 |
| USD 4 a Day Poverty Line – SEDLAC: | | | | | | |
| Rural Head count FGT(0) | 59.4 | 62.0 | 64.9 | 78.8 | 73.9 | 69.6 |
| | 63.1 | 54.2 | 51.8 | 46.6 | 51.8 | 47.9 |
| Poverty Gap FGT(1) | 27.4 | 29.0 | 30.0 | 44.0 | 40.1 | 34.8 |
| | 29.1 | 25.1 | 23.1 | 19.1 | 22.6 | 21.0 |
| Poverty and Inequality FGT (2) | 16.6 | 17.0 | 17.8 | 29.6 | 26.1 | 21.8 |
| | 17.3 | 15.2 | 13.6 | 10.4 | 13.0 | 12.3 |
| Poverty Lines: 50 percent Median household per capita income – SEDLAC: | | | | | | |
| Rural Head count FGT(0) | 32.6 | 44.1 | 45.7 | 45.4 | 51.1 | 51.2 |
| | 45.6 | 40.4 | 39.8 | 37.5 | 40.9 | 35.7 |
| Poverty Gap FGT(1) | 13.3 | 17.3 | 18.7 | 20.6 | 22.7 | 22.3 |
| | 18.7 | 17.5 | 16.5 | 14.1 | 16.9 | 15.0 |
| Poverty and Inequality FGT (2) | 7.9 | 9.1 | 10.2 | 12.5 | 13.1 | 12.9 |
| | 10.3 | 10.1 | 9.4 | 7.4 | 9.4 | 8.4 |
| CONEVAL: | | | | | | |
| Rural food per person | | 34.0 | 37.0 | 53.5 | 51.7 | 42.4 |
| | 34.0 | 28.0 | 32.3 | 24.1 | 31.3 | 29.3 |
| Rural capacity per person | | 44.1 | 47.5 | 62.6 | 59.0 | 49.9 |
| | 42.6 | 36.2 | 39.8 | 32.2 | 38.5 | 37.8 |
| Rural heritage per person | | 66.5 | 69.3 | 80.7 | 75.9 | 69.2 |
| | 64.3 | 57.4 | 61.8 | 54.1 | 60.3 | 60.8 |
| Personal Rural Welfare | 1989<br>2002 | 1992<br>2004 | 1994<br>2005 | 1996<br>2006 | 1998<br>2008 | 2000<br>2010 |

Table 11 (continued).

| Personal Rural Welfare | 1989 | 1992 | 1994 | 1996 | 1998 | 2000 |
|---|---|---|---|---|---|---|
| | 2002 | 2004 | 2005 | 2006 | 2008 | 2010 |
| Rural food per Household | | 28.0 | 30.1 | 44.1 | 43.5 | 34.1 |
| | 27.8 | 22.9 | 26.1 | 19.1 | 25.8 | 23.9 |
| Rural capacity per Household | | 36.6 | 39.4 | 53.4 | 50.9 | 41.3 |
| | 35.4 | 29.9 | 32.9 | 26.0 | 32.2 | 31.6 |
| Rural heritage per Household | | 58.2 | 61.1 | 73.1 | 69.6 | 60.7 |
| | 56.0 | 49.3 | 53.9 | 46.7 | 53.1 | 54.2 |
| Independent Variables: | | | | | | |
| Mexican Political participation (IV) | 4.0 | 4.0 | 4.0 | 4.0 | 3.0 | 2.0 |
| | 2.5 | 2.0 | 2.0 | 2.0 | 2.5 | 2.5 |
| Mexican imports of U.S. Corn (DV) Million Metric Tons | | | | | | |
| | 4856 | 521 | 3002 | 3162 | 5454 | 5945 |
| | 5288 | 5885 | 6336 | 8768 | 7841 | 7488 |
| Producer Support Estimate (PSE) - (MXN million) | | | | | | |
| | 6421 | 25689 | 23737 | 11712 | 47511 | 69918 |
| | 89137 | 47766 | 54275 | 60797 | 70406 | 78553 |
| General Services Support Estimate (GSSE) - (MXN million) | | | | | | |
| | 1733 | 3411 | 3956 | 4111 | 3818 | 5941 |
| | 6078 | 9288 | 8873 | 8449 | 9316 | 10984 |
| Consumer Support Estimate (CSE) - (MXN million) | | | | | | |
| | (2121) | (18884) | (11217) | 1542 | (31849) | (51199) |
| | (68471) | (19667) | (19088) | (19665) | (961) | (21382) |

The research question is whether and to what extent Mexican corn imports from the United States or changes in Mexican agricultural subsidies affect rural Mexican poverty? The hypotheses reflect each of these affects. For corn imports into Mexico:

$H_o$: There is not a measurable increase in poverty in rural Mexico as a result of increases in Mexican imports of corn from the United States, especially since the implementation of the North American Free Trade Agreement (NAFTA).

$H_1$: There is a measurable increase in poverty in rural Mexico as a result of increases in Mexican imports of corn from the United States, especially since the implementation of NAFTA.

The hypothesis of the Mexican agricultural subsidy effect on rural Mexican welfare:

$H_o$: Increases in Mexican agricultural subsidies result in no measurable decreases in poverty in rural Mexico, especially since the implementation of the North American Free Trade Agreement NAFTA.

$H_1$: There is a measureable decrease in poverty in rural Mexico as a result of increases in Mexican government agricultural support measured in government support estimates, especially since the implementation of NAFTA.

## Findings

Multiple measures of personal rural welfare, dependent variables, are individually regressed on four independent variables: Mexican corn imports from the United States, Mexican Producer Support Estimate (PSE) subsidies, Mexican General Services Support Estimate (GSSE) subsidies, and Mexican Consumer Support Estimate (CSE) subsidies to determine the effect of these causal variables on different measures of rural Mexican poverty. The nine regression models using Socio-Economic Database for Latin America and the Caribbean (SEDLAC) data are not found acceptable because of low R-squared values and poor significance levels of models. The results from this data are inclusive.

These multiple linear regression models include the percent of rural population with USD 2.50 a day rural headcount ($FGT_0$) for the poverty gap ($FGT_1$) and the poverty and inequality ($FGT_2$). Those surveyed with somewhat more secure financial standing at USD $4.00 per day including $FGT_0$, $FGT_1$, and $FGT_2$, and rural median 50 percent poverty line including $FGT_0$, $FGT_1$, and $FGT_2$ also possessed low R-squared values and poor model levels of significance and, therefore, are not useful predictive models.

The model for the Mexican poverty headcount ratio at the rural poverty line to the rural population, from World Bank data, provides meaningful predictive power between the independent variables and this measure of personal rural welfare. The model coefficient of determination, R-squared, is sufficiently robust to assess individual independent variables for causality at .620 and .380, respectively. The R-squared is important to this research as it adjusts for an increase in independent variables and for limited observations in the model. The model significance, the p value for F, is .1483. Of the independent variables regressed on Mexican poverty headcount ratio, only the Mexican GSSE provides a meaningful single tail p-value of .073. Its corresponding measure of magnitude, coefficient, is -.0027032. This means that for every million pesos expended by the Mexican government in general services support estimate (GSSE) subsidies the Mexican poverty headcount ratio at the rural poverty line decreases by .27. Since the average and median measures of Mexican poverty headcount over the period studied are 65.5 and 64.3, respectively, for an additional million pesos expended this measure of poverty reduces to 65.21 and 64.03.

Table 12

*Summary Regression Results by Poverty Indicator*

| Poverty Indicators | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source Model | | | | Variables | | | |
| R Square | Adj R Square | Obs. | Sig. F | IV | Coef | p-value | 1-tail |
| Poverty Headcount Ratio at Rural Poverty Line percent of Rural Population: | | | | | | | |
| 0.6202 | 0.3803 | 11 | 0.1453 | GSSE | -0.0027032 | 0.136 | 0.073 |
| USD 2.5 a Day Poverty Line - Rural Headcount FGT(0): | | | | | | | |
| 0.4552 | 0.1440 | 12 | 0.3094 | No variables with significant p-values | | | |
| USD 2.5 a Day Poverty Line - Poverty Gap FGT(1): | | | | | | | |
| 0.3701 | 0.0101 | 12 | 0.4554 | No variables with significant p-values | | | |
| USD 2.5 a Day Poverty Line - Poverty and Inequality FGT (2): | | | | | | | |
| 0.3333 | -0.0477 | 12 | 0.5243 | No variables with significant p-values | | | |
| USD 4 a Day Poverty Line - Rural Headcount FGT(0): | | | | | | | |
| 0.5729 | 0.3288 | 12 | 0.4099 | No variables with significant p-values | | | |
| USD 4 a Day Poverty Line - Poverty Gap FGT(1): | | | | | | | |
| 0.4530 | 0.1404 | 12 | 0.3130 | No variables with significant p-values | | | |
| USD 4 a Day Poverty Line - Poverty and Inequality FGT (2): | | | | | | | |
| 0.3953 | 0.0497 | 12 | 0.4097 | No variables with significant p-values | | | |
| Poverty Lines: 50 percent Median household per capita income - Rural Headcount FGT(0): | | | | | | | |
| 0.4307 | 0.1054 | 12 | 0.4391 | No variables with significant p-values | | | |
| Poverty Lines: 50 percent Median household per capita income - Poverty Gap FGT(1): | | | | | | | |
| 0.2980 | -0.1078 | 12 | 0.5980 | No variables with significant p-values | | | |
| Poverty Lines: 50 percent Median household per capita income - Poverty and Inequality FGT (2): | | | | | | | |
| 0.2111 | -0.2397 | 12 | 0.7583 | No variables with significant p-values | | | |

Table 12 (continued).

Poverty Indicators

| Source | Model | | | Variables | | | |
|---|---|---|---|---|---|---|---|
| R Square | Adj R Square | Obs. | Sig. F | IV | Coef | p-value | 1-tail |
| Rural income food poverty, by person: | | | | | | | |
| 0.5610 | 0.2683 | 11 | 0.2270 | GSSE | -0.0034829 | 0.138 | 0.069 |
| Rural income poverty of capabilities, by person: | | | | | | | |
| 0.6154 | 0.3591 | 11 | 0.1619 | GSSE | -0.003753 | 0.129 | 0.0645 |
| Rural income poverty of heritage, by person: | | | | | | | |
| 0.6256 | 0.3760 | 11 | 0.1510 | GSSE | -0.0027038 | 0.137 | 0.0682 |
| Rural income food poverty, by household: | | | | | | | |
| 0.5583 | 0.2638 | 11 | 0.2306 | GSSE | -0.0030267 | 0.132 | 0.062 |
| Rural income poverty of capabilities, by household: | | | | | | | |
| 0.5961 | 0.3269 | 11 | 0.1837 | GSSE | -0.0030664 | 0.133 | 0.0665 |
| Rural income poverty of heritage, by household: | | | | | | | |
| 0.5958 | 0.3264 | 11 | 0.1840 | GSSE | -0.0029123 | 0.129 | 0.0645 |

The six models in which a proxy for personal rural welfare data, from the Mexican National Council for Evaluation of the Social Development Policy (CONEVAL), is regressed on the independent variables of Mexican corn imports, PSE, GSSE, and CSE provide meaningful predictive power between the independent variables and the associated measures of personal rural welfare.

The percent rural income food poverty by person of the total rural population model has a coefficient of determination, R-squared, that is sufficiently robust to assess individual independent variables for causality at .561 and .268, respectively. The model significance is .2270. Of the independent variables regressed on percent rural income food poverty by person, only the Mexican GSSE provides a meaningful p-value of .138 with a single tail value of .069. Its corresponding measure of magnitude, coefficient, is -.0034829. This means that for every million pesos expended by the Mexican government in general services support estimate (GSSE) subsidies the Mexican percent rural income food poverty per person decreases by .34. Since the average and median measures of percent rural income poverty by person over the period studied are 36.1 and 34, respectively, for an additional million pesos expended this measure of poverty reduces to 35.80 and 33.62.

The percent rural income poverty of capabilities by person of the total rural population model has a coefficient of determination, R-squared, that is sufficiently robust to assess individual independent variables for causality at .615 and .359, respectively. The model significance is .1619. Of the independent variables regressed on percent rural income poverty of capabilities by person, only the Mexican GSSE provides a meaningful p-value of .129 with a single tail value of .065. Its corresponding measure of magnitude, coefficient, is -.003753. This means that for every million pesos expended by the Mexican government in general services support estimate (GSSE) subsidies the Mexican percent rural income poverty of capabilities per person decreases by .38. Since the average and median measures of percent rural income poverty of capabilities by person over the period studied are 44.6 and 42.6, respectively, for an additional million pesos expended this measure of poverty reduces to 44.23 and 42.23.

The percent rural income poverty of heritage by person of the total rural population model has a coefficient of determination, R-squared, that is sufficiently robust to assess individual independent variables for causality at .626 and .376, respectively. The model significance is .1510. Of the independent variables regressed on percent rural income poverty of heritage by person, only the Mexican GSSE provides a meaningful p-value of .137 with a single tail value of .068. Its corresponding measure of magnitude, coefficient, is -.002704. This means that for every million pesos expended by the Mexican government in general services support estimate (GSSE) subsidies the Mexican percent rural income poverty of heritage per person decreases by .27. Since the average and median measures of percent rural income poverty of heritage by person over the period studied are 65.5 and 64.3, respectively, for an additional million pesos expended this measure of poverty reduces to 65.23 and 64.03.

The percent rural income food poverty by household of the total rural population model has a coefficient of determination, R-squared, that is sufficiently robust to assess individual independent variables for causality at .558 and .264, respectively. The model significance is .2306. Of the independent variables regressed on percent rural income food poverty by person, only the Mexican GSSE provides a meaningful p-value of .132 with a single tail value of .062. Its corresponding measure of magnitude, coefficient, is -.0030267. This means that for every million pesos expended by the Mexican government in general services support estimate (GSSE) subsidies the Mexican percent rural income food poverty per person decreases by .31. Since the average and median measures of percent rural income poverty by household over the period studied are 29.6 and 27.8, respectively, for an additional million pesos expended this measure of poverty reduces to 29.3 and 27.5.

The percent rural income food poverty by household of the total rural population model has a coefficient of determination, R-squared, that is sufficiently robust to assess individual independent variables for causality at .596 and .327, respectively. The model significance is .1837. Of the independent variables regressed on percent rural income food poverty by person, only the Mexican GSSE provides a meaningful p-value of .133 with a single tail value of .0665. Its corresponding measure of magnitude, coefficient, is -.0030664. This means that for every million pesos expended by the Mexican government in general services support estimate (GSSE) subsidies the Mexican percent rural income food poverty per person decreases by .31. Since the average and median measures of percent rural income poverty by household over the period studied are 37.2 and 35.4, respectively, for an additional million pesos expended this measure of poverty reduces to 36.9 and 35.1.

The percent rural income poverty of heritage by household of the total rural population model has a coefficient of determination, R-squared, that is sufficiently robust to assess individual independent variables for causality at .596 and .326, respectively. The model significance is .1840. Of the independent variables regressed on percent rural income poverty of heritage by person, only the Mexican GSSE provides a meaningful p-value of .129 with a single tail value of .0645. Its corresponding measure of magnitude, coefficient, is -.0029123. This means that for every million pesos expended by the Mexican government in general services support estimate (GSSE) subsidies the Mexican percent rural income poverty of heritage per person decreases by .29. Since the average and median measures of percent rural income poverty of heritage by household over the period studied are 57.8 and 56, respectively, for an additional million pesos expended this measure of poverty reduces to 57.51 and 55.71.

Since the models do not indicate relation between the Mexican corn imports from the United States and Mexican rural poverty the null hypothesis cannot be rejected and there is no evidence from the data that poverty in rural Mexico is predicted by increases of Mexican imports of corn from the United States. This is also true of the producer (PSE) and consumer (CSE) Mexican government agricultural subsidies. The null hypotheses for these subsidies cannot be rejected. There is, however, reasonable evidence from the World Bank data and all measures of poverty from CONEVAL that agricultural infrastructure (GSSE) expenditures predict lower levels of Mexican rural poverty. The null hypotheses for these causal variables are rejected.

## Analysis

Although rural Mexican welfare is presented in several peer reviewed databases, the rural Mexican poverty data has its origin in the Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH) or National Household Income and Expenditure Surveys. Though rural poverty data is collected biannually the ENIGH surveys are the best and closest to the source of the data we have for measures of rural Mexican welfare. Szekely (2005) underscores that though some of this data has been collected under the auspices of various Mexican government agencies since 1950, more recent data collection under the direction of the National Institute of Statistics and Geography (INEGI) is both more consistent from year to year and more reliable.

Findings indicate that measures of Mexican rural headcount ratio, noted by the World Bank, and Mexican rural income percentages, noted by CONEVAL, are predicted by the causal variables used in these models, whereas the measures associated by the rural poverty lines, noted by SEDLAC, are not. A significant portion of the variation in the measures of rural poverty, the dependent variables from the World Bank and CONEVAL is predicted by the independent variables in these models.

Table 13

*Model Level Regression Summary*

| Source/ Model | R Square | Adj R Square | Obs. | Sig. F |
|---|---|---|---|---|
| World Bank: | | | | |
| 1. Poverty Headcount Ratio | 0.6202 | 0.3803 | 11 | 0.1453 |
| CONEVAL: | | | | |
| 2. Rural income food poverty by person | 0.5610 | 0.2683 | 11 | 0.2270 |
| 3. Rural income poverty of capability by person | 0.6154 | 0.3591 | 11 | 0.1619 |
| 4. Rural income poverty of heritage by person | 0.6256 | 0.3760 | 11 | 0.1510 |
| 5. Rural income food poverty by household | 0.5583 | 0.2638 | 11 | 0.2306 |
| 6. Rural income poverty of capability by household | 0.5961 | 0.3269 | 11 | 0.1837 |
| 7. Rural income poverty of heritage by household | 0.5958 | 0.3264 | 11 | 0.1840 |

When adjusted for the limited number of observations, R-squared, these models predict from 26 to 38 percent of the variation in the various measures of rural Mexican poverty. In all of these seven models the General Services Support Estimate (GSSE) is found to have significance above 90 percent. Mexican imports of corn from the United States and other subsidy measures (PSE and CSE) do not. The GSSE one-tail p-values fall between .0620 and .0730. The GSSE also have negative coefficients, indicating that as the Mexican GSSE increases, rural Mexican poverty levels decrease. Among these seven models the effect size of these coefficients ranges from .27 to .34, indicating that for every million pesos invested in the GSSE the corresponding Mexican rural poverty percent decreases by those amounts. Although the weakness of the models exists due to observational limitations resulting in relatively less robust predictability at the model level, these coefficients are significant. All seven of these models indicate that for every three million pesos additionally invested by the Mexican government in GSSE, the survey estimates of rural Mexican poverty decrease by approximately one percent.

Durbin-Watson test of the model reveals Durbin-Watson Statistic D values for the independent variables with significant p-values between the lower critical value $D_L$ and the upper critical value $D_U$, indicating inability to determine positive autocorrelation of this data set with the Durbin-Watson test.

Table 14

*Durbin-Watson Statistic Values*

| Model, IV | k | n | D | DW table used | DL | DU |
|---|---|---|---|---|---|---|
| PRW01, GSSE | 5 | 11 | 0.460234 | 5% | 0.315 | 2.645 |
| PRW11, GSSE | 5 | 11 | 0.489823 | 5% | 0.315 | 2.645 |
| PRW12, GSSE | 5 | 11 | 0.421903 | 5% | 0.315 | 2.645 |
| PRW13, GSSE | 5 | 11 | 0.459180 | 5% | 0.315 | 2.645 |
| PRW14, GSSE | 5 | 11 | 0.482034 | 5% | 0.315 | 2.645 |
| PRW15, GSSE | 5 | 11 | 0.406122 | 5% | 0.315 | 2.645 |

Table 14 (continued).

| Model, IV | k | n | D | DW table used | DL | DU |
|---|---|---|---|---|---|---|
| PRW16, GSSE | 5 | 11 | 0.422259 | 5% | 0.315 | 2.645 |

Time series plot summaries or trend graphs for these data show significant trends in the data throughout the period studied. Mexican imports of maize dramatically increased through the period from 521 Million Metric Tons (MMT) in 1992 to 7,480 MMT in 2010, a thirteen-fold increase. The Mexican Producer Support Estimate (PSE) and the Mexican General Services Support Estimate (GSSE) significantly increased through the period, while the Mexican Consumer Support Estimate (CSE) remained flat. The PSE increased from 25.688 billion pesos in 1992 to 78.552 billion pesos in 2010, a two-fold increase, and the GSSE increased from 3.410 billion pesos in 1992 to 10.983 billion pesos in 2010, also a two-fold increase throughout the period. The CSE from 1992 to 2010 increased at a much slower rate from -18.844 billion pesos to -21.382 billion pesos. It is important to note that CSE expenditures are defined as negative expenditures. All of the causal variables examined dropped measurably during the 1995 peso crisis in Mexico.

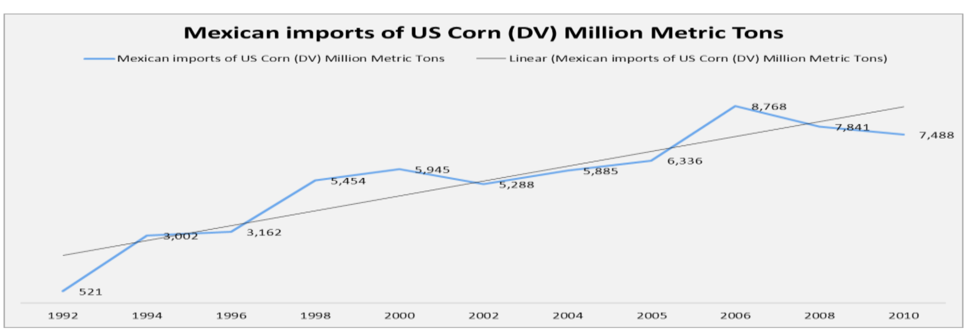


*Figure 8*. Mexican imports of United States corn in Million Metric Tons.

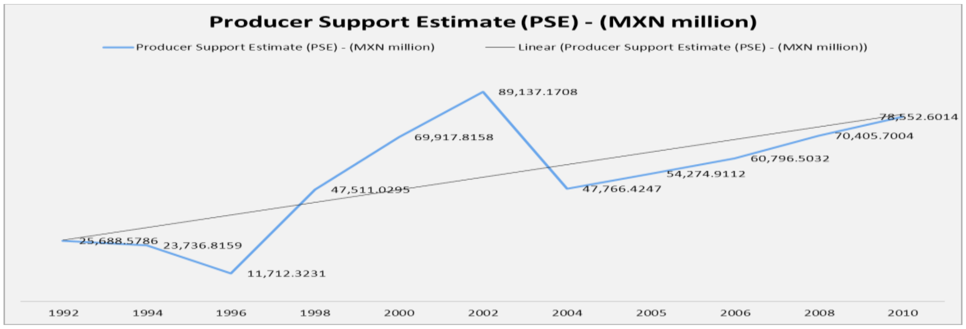


*Figure 9*. Producer Support Estimate (PSE)-(MXN million).

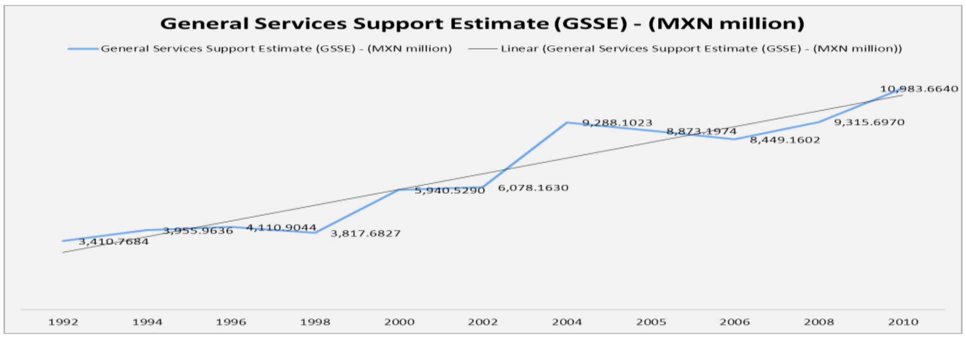


*Figure 10*. General Services Support Estimate (GSSE)-(MXN million).

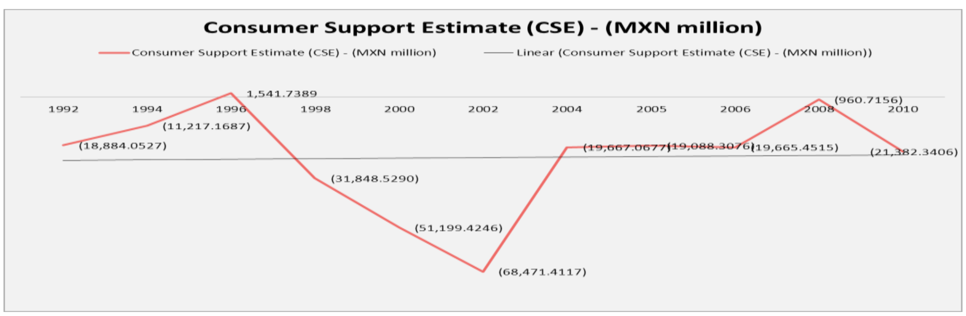


*Figure 11*. Consumer Support Estimate (CSE)-(MXN million).

It is also significant that all measures of Mexican rural poverty trended down over the twenty-two year period, but all measures of Mexican rural poverty increased measurably during the 1995 Mexican peso crisis. Since these values measure population poverty rates, real rural income is implied over the period studied. Mexican rural poverty trends of significant models of poverty trends are shown in Figures 12 through 18.

Mexican rural poverty trends of less significant models also show similar patterns of decreasing poverty and are included in Figures 19 through 27.

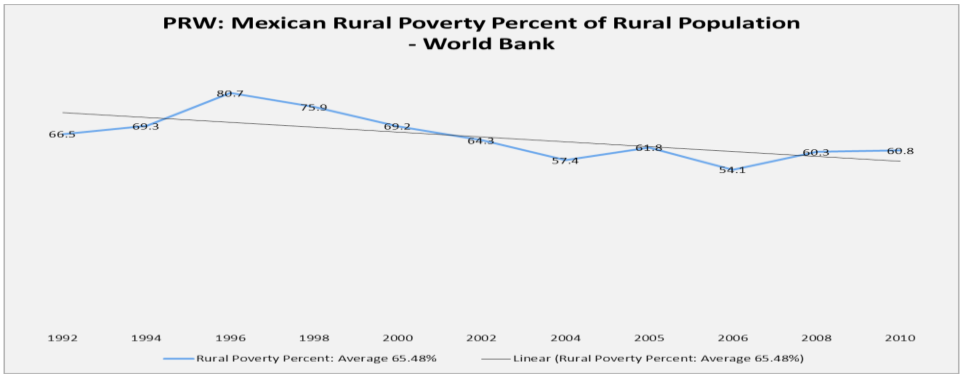


*Figure 12*. Significant models: Mexican rural poverty percent of rural population-World Bank.

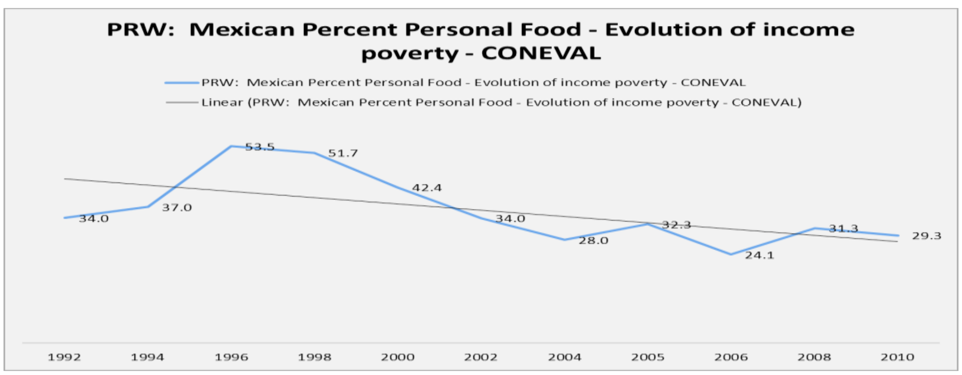


*Figure 13*. Significant models: Mexican percent personal food-evolution of income poverty-CONEVAL.

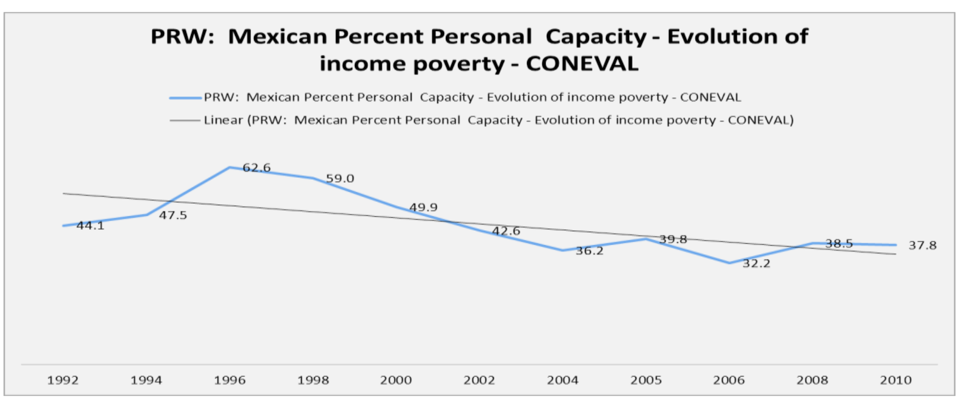


*Figure 14*. Significant models: Mexican percent personal capacity-evolution of income poverty-CONEVAL.

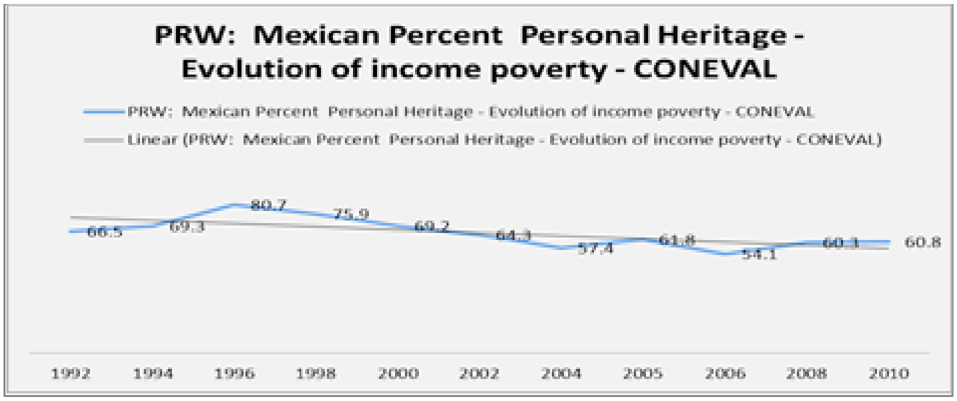


*Figure 15*. Significant models: Mexican percent personal heritage-evolution of income poverty-CONEVAL.

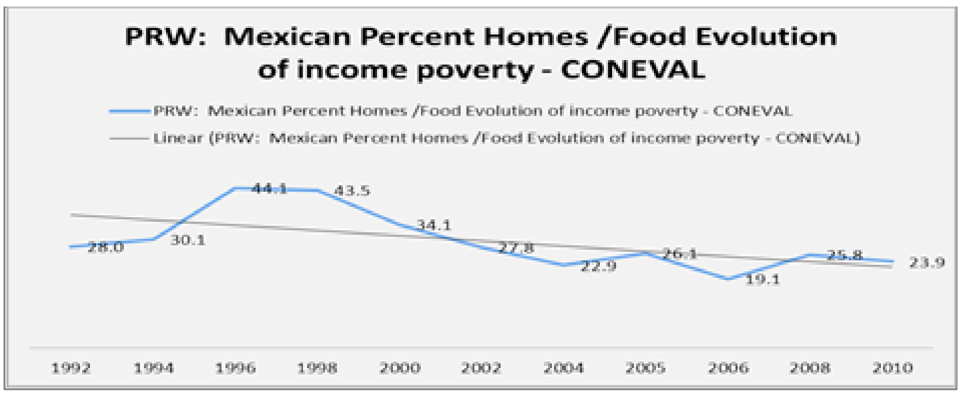


*Figure 16*. Significant models: Mexican percent homes-food evolution of income poverty-CONEVAL.

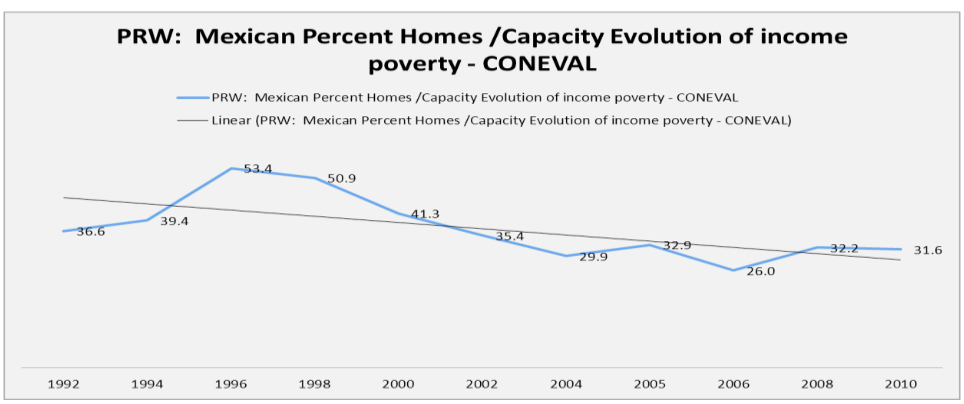


*Figure 17*. Significant models: Mexican percent homes-capacity evolution of income poverty-CONEVAL.

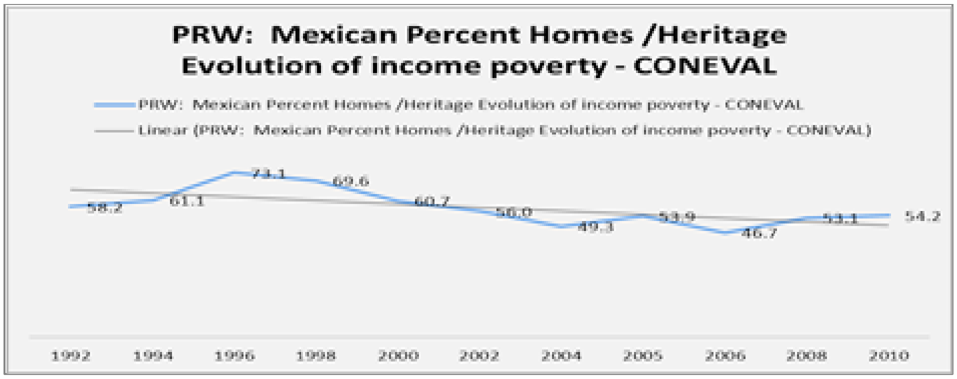


*Figure 18*. Significant models: Mexican percent homes-heritage evolution of income poverty-CONEVAL.

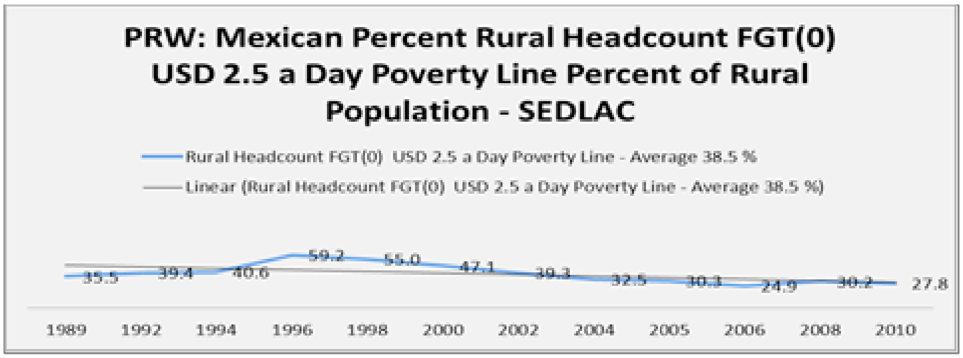


*Figure 19*. Mexican rural poverty trends of less significant models; Mexican percent rural headcount FGT(0) USD $2.50 per day poverty line percent of rural population-SEDLAC.

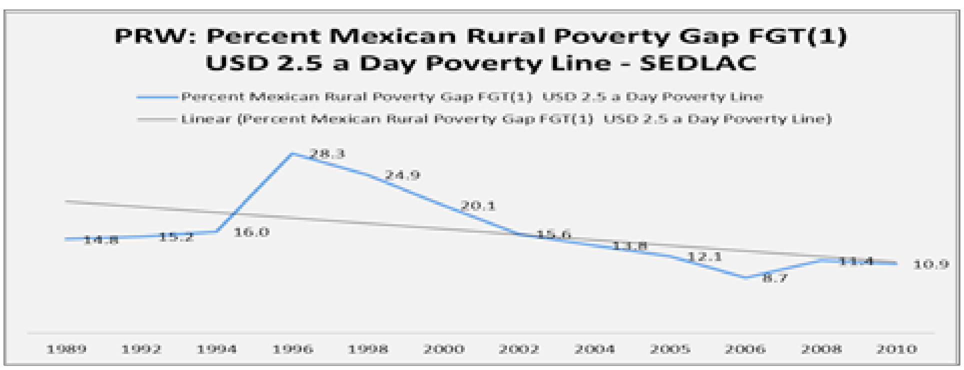


*Figure 20*. Mexican rural poverty trends of less significant models; percent Mexican rural poverty gap FGT(1), USD $2.50 per day poverty line-SEDLAC.

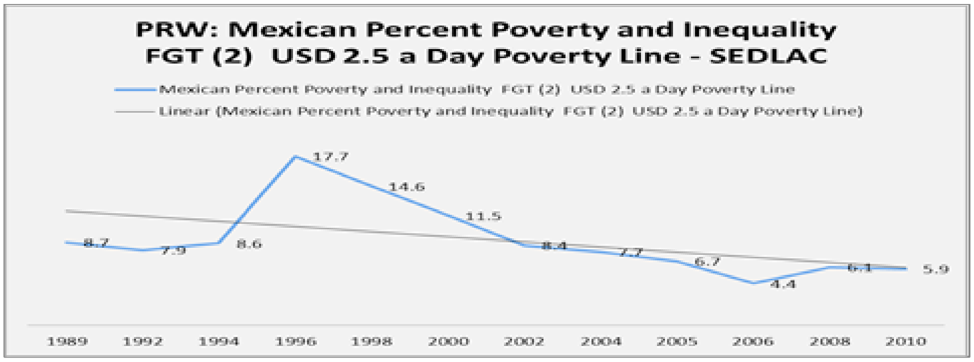


*Figure 21*. Mexican rural poverty trends of less significant models; Mexican percent poverty and inequality FGT(2), USD $2.50 per day poverty line-SEDLAC.

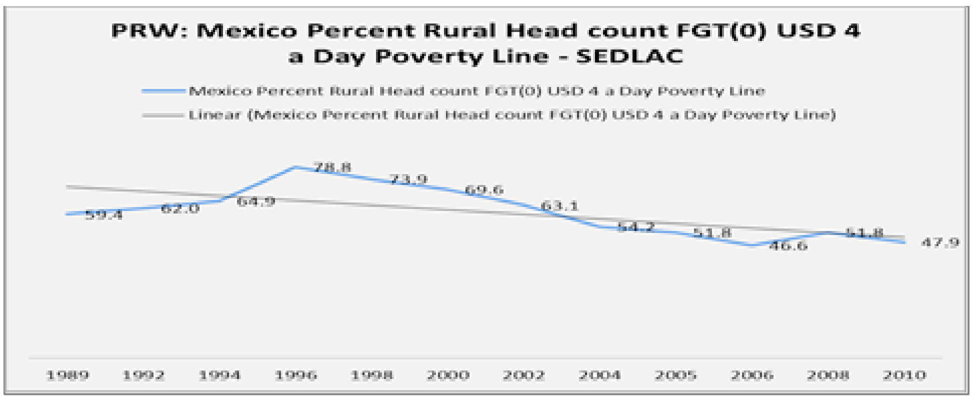


*Figure 22*. Mexican rural poverty trends of less significant models; Mexican percent rural head count FGT(0), USD $4.00 per day poverty line-SEDLAC.

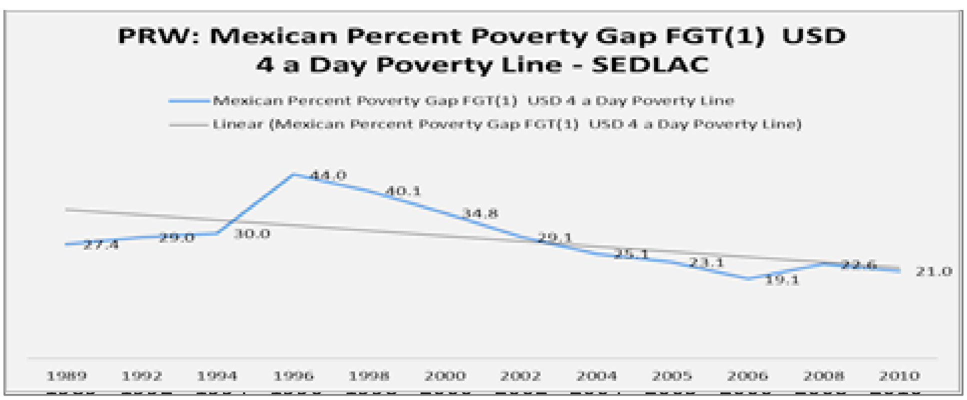


*Figure 23*. Mexican rural poverty trends of less significant models; Mexican percent poverty gap FGT(1), USD $4.00 per day poverty line-SEDLAC.

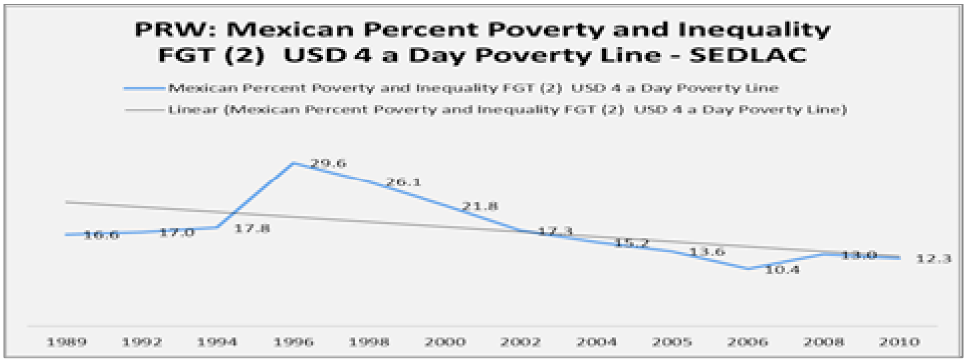


*Figure 24*. Mexican rural poverty trends of less significant models; Mexican percent poverty and inequality FGT (2), USD $4.00 per day poverty line-SEDLAC.

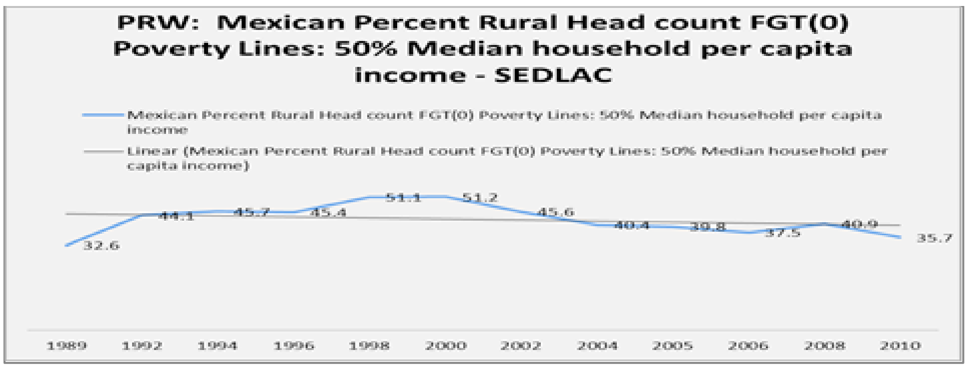


*Figure 25*. Mexican rural poverty trends of less significant models; Mexican percent rural head count FGT (0), poverty lines: 50 percent median household per capita income-SEDLAC.

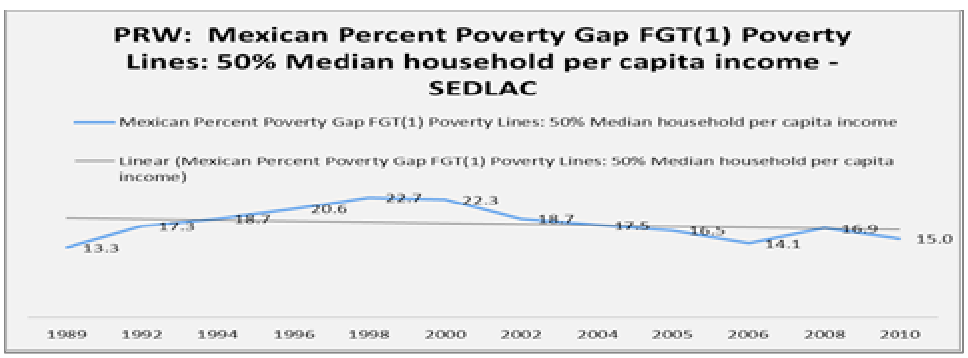


*Figure 26*. Mexican rural poverty trends of less significant models; Mexican percent poverty gap FGT (1), poverty lines: 50 percent median household per capita income-SEDLAC.

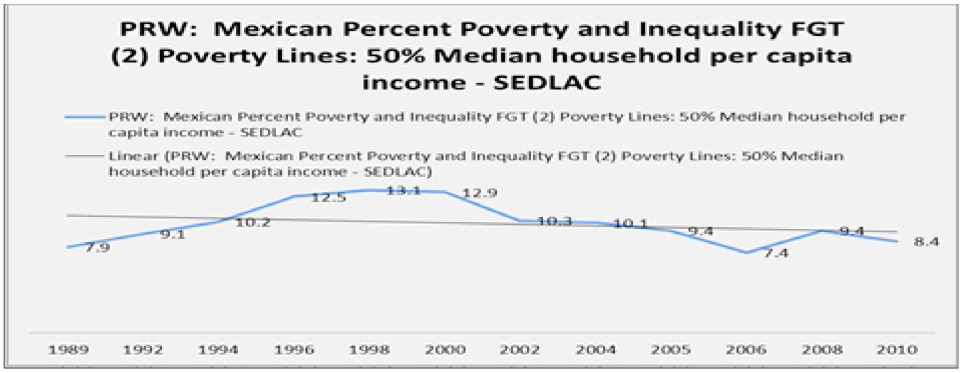


*Figure 27*. Mexican rural poverty trends of less significant models; Mexican percent poverty and inequality FGT (2), poverty lines: 50 percent median household per capita income-SEDLAC.

These findings are consistent with what Szekely (2005, 923) finds about poverty in Mexico declining between 1950 and 1984, remaining flat between 1984 and 1994, increasing through 1996, and then decreasing. Szekely (2001, 241) also describes changes in social policies as generations of policies with different focuses and intended outcomes. The changes in macroeconomic conditions for Mexico such as the 1994-96 peso crisis and what Esquivel (2010, 4) describes as Mexican changes in the delivery of social protection may have a more significant impact on the personal welfare of the Mexican rural poor than corn imports from the United States or the composite amounts of Mexican government agricultural subsidies for producers (PSE) and consumers (CSE).

## Conclusions

This research looks inside the Mexican economy to evaluate the Mexican rural welfare at a national, composite level. The findings of this study indicate despite these overall trends, Mexican General Services Support Estimate (GSSE) possesses a significant and measurable inverse relationship to rural Mexican poverty measured at most levels. Other potentially causal variables are not shown to affect the measured rural Mexican poverty levels. Mexican producer and consumer agricultural subsidies and

Mexican corn imports do not show a causal link to rural Mexican poverty. The balance of available data does not conclude that as imports of corn from the United States (unbalanced trade) increase that any segment of the rural Mexican population is worse off.

This study also underscores the need for more time-series data to advise public policy. Researchers such as Szekely (2005) in an effort to assess poverty have sought variations in data, but the need for additional, consistently surveyed, reliable time-series data will in all likelihood only be met with time and consistent commitment to population surveys. Time series data is essential to understanding historical trends and, as Hernandez and Szekely (2009) note, limited annual data restricts viable explanation of Mexican rural poverty. More data over longer timeframes will contribute to stronger models and increase our understanding of fundamental causes of Mexican rural poverty. Until then, alternate approaches to discern causality must be used. Szekely's (2005) approach to drill deeper within existing variables and Foster et al. (1984) FGT measures of poverty to sub-divide variables available and will allow some measure of consistency of observations to assess the personal welfare of the rural Mexican poor.

# CHAPTER IV

# RURAL MEXICAN RESPONSES TO LOST AGRICULTURAL EMPLOYMENT: MIGRATION AND OTHER SURVIVAL MECHANISMS

## Introduction

As Allee et al. (1949, 539) point out, “an organism has but three choices available when exposed to adversity: it may die, adjust, or migrate. Hibernation and aestivation are broad adjustments to adverse weather or climate. Migration is another way to avoid unfavorable conditions.” From the earliest formal research of human migration, Ravenstein (1885) demonstrates the importance of financial incentives of migration among people groups. This chapter posits that rural Mexican population responds to lost employment opportunities by emigrating to locations of opportunity such as large Mexican cities and to the United States.

## Review of the Literature

### *Theoretical Background*

Allee et al. (1949) point out that

> migration . . . has become divided into at least three categories: . . . a more or less continuous and direct movement . . . from one locality to another, in which there is a periodic return to the original locality; . . . a movement of a portion of a species population, often over great distances, to another locality, without a return to the original area; and . . . remigration, a movement of a portion of a species population from one locality to another, with a return movement to the original locality. (529)

As Allee et al. (1949) note it is not just poor survival environment, but comparatively less desirable environments that incentivize beings to migrate. “In Mexico, the rural wage increased from 28 percent of the urban wage in 1992 to 40 percent in 2002” (World Bank 2007, 216). Papademetriou (2008) notes the implementation of

NAFTA led to a movement of labor that neither Mexico nor the United States was prepared to address. Kuznets (1955, 8) in a theoretical review of income inequality builds on the premise that urban industrial sectors have higher per capita productivity than agriculture and subsequently higher incomes. He posits that rural emigration occurs among lower-income levels (Kuznets 1955, 9) and that the dynamic of the hope of personal and family improvement is a significant economic incentive for personal change (Kuznets 1955, 10, 24). Theoretically the earnings inequality between agriculture and urban sectors widens over time (Kuznets 1955, 12-18). The process of economic growth has "shattering effects" on an existing economic infrastructure, first widening inequality, then narrowing it (Kuznets 1955, 18). During the phase of widening income inequality a minimal middle class exists (Kuznets 1955, 20-21), and so pathways to personal-familial economic improvement are limited. Kuznets warns against prescribing growth paths of developed countries with "completely free markets, lack of penalties implicit in progressive taxation, and the like are indispensable for . . . economic growth" to developing countries (Kuznets 1955, 26). Kuznets concludes his discussion of income inequality with the caution that distribution is a focal point of a functioning economic system and that populations are aware of that distribution, noting that societies are acutely aware and are interested in that distribution (Kuznets 1955, 27). The United States Commission for the Study of International Migration and Cooperative Economic Development (USCSIMCED) report to the United States Congress (1990) noted that the main motivation for Mexican migration to the United States is economic. Black, Kolesnikova, and Taylor remind us that, although theorists "in labor supply studies [tend] to ignore prices other than wages," prices of relevant consumption goods must be included with wages in evaluating labor supply decisions (2009, 613). Hanson (2003, 15) documents the scope of Mexican rural-to-urban migration. Population in cities with more than 500,000 inhabitants rose by four to five percent, and towns with less than 2,500 fell by three to four percent between 1990 and 2000. Bhagwati (2004, 55) posits that an economy can grow and paradoxically "immiserize" a country and its poor, unless developmental policies are concurrently implemented. Bhagwati uses the term "immiserize" to describe how an economy and the welfare of a people can become worse off even though it has "grown through accumulating capital or improving productivity" Bhagwati (2004, 55).  Public policies and growth paths can affect the poor differently and so must address the unintended effects of growth policies (Bhagwati 2004, 56).

*History and Pressures to Migrate*

Mexican migration to the United States dates from the mid-nineteenth century, driven by the economic growth and territorial expansion of the United States (Delgado-Wise and Covarrubias 2007, 664). The United States' Bracero Program (1942-1964) coordinated Mexican guest workers, especially from rural central western Mexico (Fussell 2004, 938).

Delgado-Wise and Covarrubias (2007) note that the integration of the Mexican economy with the United States results in significant Mexican emigration and resultant asymmetries between the two countries in "employment insecurity, poverty, and social marginalization" (2007, 656). They contend that the classical migration model of Harris and Todaro (1970) does not consider the costs of migration, risk assessment, relative deprivation, or the role of social capital in decisions to migrate.

Motivations to migrate vary. They are enhanced by financial market failures in the migrant's home country. Less skilled workers tend to rely on rural-based social networks for migration assistance, while those with greater human capital tend to use them less and some even enter the United States in search of "adventure" (Fussell 2004, 940). Familial decisions in Mexico to financially support emigration are often made as investments with expectations to receive return through remittances. Reynoso, Villarreal, and Gomez (2009) note that certain sending family sizes, wealth, expectations and needs tend to positively affect these remittances and include home ownership and even family ownership of a truck. Reynoso et al. (2009) also note that those with *greater preparation*, skill and educational attainment, tend to migrate to areas of increased opportunity, and there is an inverse relationship between the migrant's education and funds remitted to the family. Both Stecklov, Winters, Stampini, and Davis (2005) and Hanson (2006) note that increases in educational attainment are associated with increased migration, but less so among college graduates. Hanson (2006) also notes that though increased education is associated with migration to the United States, the inverse is true for work related skills. Less skilled Mexicans tend to migrate to the United States at a higher rate than those with more developed skills. The geographic origin of emigration is changing from western Mexico to the interior urban communities (Fussell 2004, 962).

Delgado-Wise and Covarrubias (2007) conclude that migration is a complex process and effective government policy must involve developing different ways to integrate regionally, reducing asymmetries and promoting alternative Mexican development models. Fitzgerald (2006) sees Mexican emigration restrictions implemented in a bureaucratic division of multiple conflicting governing bodies in

Mexico. Incentives to migrate are so strong that families arrange for long separations (Frank and Wildsmith 2005, 920). Krissman (2005) maintains that migration networks seldom originate individual hometowns, that migration from individual locales is not self-perpetuating, but that labor recruiting creates and perpetuates migratory flows. Mishra (2007) empirically investigates the demand for labor as emigration occurs from Mexico and finds a strong and positive impact of the outflow of workers on wages in Mexico. Mishra finds that as emigration occurs, the more educated who remain benefit substantially more than the less educated from the increased labor demand in Mexico that results from the decreased domestic labor supply in the sending country.

A long term, culturally based emigration structure has developed in Mexico. Boehm (2008, 780) finds that migration decisions almost always center on children, and that "the multiple migration decisions parents face . . . are directly linked to the well-being of family members, particularly the youngest." "The words 'for my children' have become a trope linking migration to the next generation" (Boehm 2008, 786). VanWey (2005) finds that land ownership affects migration rates as a store of wealth, a source of employment, an investment, and as a device of ownership, and that subsequent migration responses vary.

*Migration Experience*

Sana (2008, 995) attributes migrant remittances to the growth in the migration rate referring to it as the "migration effect." Sana also correlates migration and subsequent remittance rates to the economic growth of the receiving country. Novoa and Sanabria (2008) find that migrants view national borders as a transnational area, and not as a thin line dividing one country from another. Migrant flows respond to expansion of emerging markets and shrink as employment demand lessens. Cassarino (2004, 275) concludes that migrant return is "influenced by the initial motivations for migration" and conditions and duration of stay. Whether one holds to neo-classical international migration theory, as in Todaro (1969, 140), that migration choice is permanent or to the new economic labor migration theory, as articulated by Cassarino (2004), that return from a migratory experience is part of the initial migration strategy, the influences of initial choices of the migrant to relocate are significant.

## Theoretical Framework

Kuznets' (1955, 1971) theory of economic growth and income inequality explains the dynamic shown in this study that lower personal welfare provides incentives for the rural Mexican population to emigrate to locations of opportunity, specifically to the United States to seek work and higher wages. Hanson (2003) shows the changing population demographics of smaller Mexican towns and larger cities. Allee et al. (1949) and Ravenstein (1885) indicate that there are often common forces that induce migration, but for Mexico there is a disproportionately higher percentage of emigration of rural residents migrating to the United States than those from urban or suburban Mexico. Papademetriou (2008) and Ravenstein (1885) note economic incentives as important motivators to migrate. Bhagwati (2004) and Todaro (1969) note that internal economic policies often result in lower personal welfare, which adds to economic incentives to emigrate. VanWey (2005) outlines forms of wealth other than wages that contribute to or inhibit emigration. Mathews (2007) notes that common cultural values impact the selection of destinations within a receiving country. Aguilera-Guzman et al. (2004) demonstrate the effect of these common cultural values in destinations in the United

States. Fussell (2004) and Krissman (2005) address the importance of receiving countries enforced immigration policies on decisions to migrate. Fitzgerald (2006) provides a complementary perspective from the sending country policies that contribute to strength of the receiving country's immigration policies. Delgado-Wise and Covarrubias (2007), Black, Kolesnikova, and Taylor (2009), and Novoa and Sanabria (2008) outline immigrant concerns as they enter a new country, and Aguilera-Guzman et al. (2004) , and Frank and Wildsmith (2005) specifically address uncertainties in immigration that underscore those concerns.

## Methodogy

The propensity to migrate to locations of opportunity, especially to large urban centers in Mexico and to the United States is affected by several variables. To determine the strength and likelihood, a regression model is developed on these variables evaluated from the 1980 to present. Hernandez and Szekely (2009, 36) note that lack of data "impede the use of solid statistical techniques to determine the significance of the underlying relationships." This is especially true for national Mexican rural poverty data, which for the most part is limited to 1984, 1989, and to more thorough surveys conducted biannually from 1992 to the present. Hernandez and Szekely (2009, 37) address the necessity to "obtain the longest possible time-series data on macroeconomic performance and on poverty levels," but time-series detail is less available for Mexico. This analysis regresses net Mexican migration on the independent variables of personal rural welfare in Mexico, defined as personal wealth and employment, financial opportunity in the United States, the strength of common cultures in destination locations that may include the existence of common religious populations and personal, culturally-based relationships, favorable receiving country policies, and ease of relocation including out of pocket costs and uncertainty. This is shown as:

$$Y = B_0 + B_1x_1 + \ldots B_nx_{tn} + U_t$$

Such that, M = f (PRW, FO, CV, GP, RE), where M is the net migration of Mexican citizens to the United States, and PRW are measures of the personal rural welfare in Mexico. FO is the financial opportunity in the United States measured in the median income of Hispanics in the United States. CV is composite cultural values and is measured as a proxy, the average number of personal Chicano relationships of Mexican immigrants in the United States. GP is a measure of immigrant policies in the receiving country and is measured as a proxy, the average number of deportations experienced by heads of household from Mexico on a first migration attempt. RE is a measure of the ease of relocation including financial costs, and uncertainty is measured as a proxy, the average Hispanic unemployment rate in the United States. This is a summary proxy that approximates costs that can include the costs of coyotes, family separation, and perils from organized crime in the transnational area.

Net migration of Mexican citizens to the United States (M) data is from the United States Census Bureau and measures net migration between the two countries from 1980 to present. Personal rural welfare (PRW) is accounted for using eighteen separate measures of well-being. Fifteen are from data for the years 1984, 1989, and biannually from 1992 to 2010. Three separate measures are from 1980 to 2010. These data are gathered from the World Bank, the Comisión Económica para América Latina y el Caribe or Economic Commission for Latin America and the Caribbean (CEPAL), and the Socio-Economic Database for Latin America and the Caribbean (SEDLAC). These official database sources are based on data gathered by the Mexican Encuesta Nacional de Ingresos y Gastos de los Hogares or National Survey on Household Income and Expenditures (ENIGH).

Measures of personal rural welfare include Mexican rural poverty as a percent of the rural population, and the calculated rural/urban poverty ratio sources from the World Bank, the Mexican rural population in poverty and extreme poverty percentages, and the Mexican rural household in poverty and extreme poverty percentages from CEPAL. They include measures of population and households in poverty and extreme poverty, the total Mexican unemployment rate, the rural to total Mexican unemployment ratio, and the rural to total Mexican ratio of unemployment. Nine Foster et al. (FGT) poverty indicators (Foster et al. 1984) from SEDLAC provide additional rural poverty measurements. These include Mexican rural headcount ($FGT_0$) at USD $2.50/day and USD $4.00/day, Mexican rural poverty gap ($FGT_1$) at USD $2.50/day and USD $4.00/day, and poverty and inequality measures ($FGT_2$) at USD $2.50/day and USD $4.00/day, as well as the 50 percent median household per capita income for Mexican rural headcount ($FGT_0$), Mexican rural poverty gap ($FGT_1$), and poverty and inequality ($FGT_2$). The total rural unemployment percentage, rural to total unemployment ratio, and the population employed in the rural sector are derived from CEPAL-STAT database. These last three provide data from 1980 to 2010 and so provide more robust modeling.

Table 15

*Mexican Rural Welfare Indicators*

| Source | Data |
|---|---|
| World DataBank | World Development Indicators (WDI) and Global Development Finance (GDF) |
| WDI/GDF | Poverty Headcount Ratio at Rural Poverty Line ( percent of Rural Population) |
| Calculated | Rural to Urban Poverty Ratio (Rural percent / Urban percent) |
| Comisión Económica para América Latina y el Caribe; Economic Commission for Latin America and the Caribbean (CEPAL) | |
| CEPAL | Mexican Rural Population in Poverty percent |
| CEPAL | Mexican Rural Population in Extreme Poverty percent |
| CEPAL | Mexican Rural Households in Poverty percent |
| CEPAL | Mexican Rural Households in Extreme Poverty percent |
| Calculated | Total Mexican Unemployment Rate G= [ e/(c+e) ] |
| CEPAL | Total Employed Work Force [c] |
| CEPAL | Total Unemployed Work Force [e] |
| Calculated | Rural/Total Unemployment Ratio H=[ f/(d+f) ] |
| CEPAL | Employed Rural Work Force [d] |
| CEPAL | Total Unemployed Rural Work Force [f] |
| Calculated | Mexican Population Employment Rural/total Sector (H /G) |
| Socio-Economic Database for Latin America and the Caribbean (SEDLAC) | |
| Rural Headcount FGT(0) | USD 2.5 a Day Poverty Line |
| Poverty Gap FGT(1) | USD 2.5 a Day Poverty Line |

Table 15 (continued).

| Source | Data |
|---|---|
| Poverty and Inequality FGT(2) | USD 2.5 a Day Poverty Line |
| Rural Headcount FGT(0) | USD 4 a Day Poverty Line |
| Poverty Gap FGT(1) | USD 4 a Day Poverty Line |
| Poverty and Inequality FGT(2) | USD 4 a Day Poverty Line |
| Rural Headcount FGT(0) | Poverty Lines: 50 percent Median household per capita income |
| Poverty Gap FGT(1) | Poverty Lines: 50 percent Median household per capita income |
| Poverty and Inequality FGT(2) | Poverty Lines: 50 percent Median household per capita income |

Personal Rural Welfare Data (PRW) for these rural Mexican poverty measures is shown in the following tables. World Bank data and CEPAL data are shown in Table 16, containing personal rural welfare indicators PRW01 – PRW06, CEPAL and SEDLAC data are shown in Table 17, PRW07 – PRW12; and SEDLAC data are shown in Table 18, PRW13 – PRW18.

Table 16

*World Bank and CEPAL Mexican Rural Welfare Data: PRW01 – PRW06*

| Year | PRW01 | PRW02 | PRW03 | PRW04 | PRW05 | PRW06 |
|---|---|---|---|---|---|---|
| 1980 | | | | | | |
| 1981 | | | | | | |

Table 16 (continued).

| Year | PRW01 | PRW02 | PRW03 | PRW04 | PRW05 | PRW06 |
|---|---|---|---|---|---|---|
| 1982 | | | | | | |
| 1983 | | | | | | |
| 1984 | | | 53.5 | 25.4 | 45.0 | 19.7 |
| 1985 | | | | | | |
| 1986 | | | | | | |
| 1987 | | | | | | |
| 1988 | | | | | | |
| 1989 | | | 56.7 | 27.9 | 48.3 | 22.4 |
| 1990 | | | | | | |
| 1991 | | | | | | |
| 1992 | 66.5 | 1.50 | 54.9 | 25.7 | 46.4 | 19.9 |
| 1993 | | | | | | |
| 1994 | 69.3 | 1.68 | 56.5 | 27.5 | 46.5 | 20.4 |
| 1995 | | | | | | |
| 1996 | 80.7 | 1.31 | 62.8 | 33.0 | 53.4 | 25.0 |
| 1997 | | | | | | |
| 1998 | 75.9 | 1.36 | 58.5 | 31.1 | 49.3 | 23.5 |
| 1999 | | | | | | |
| 2000 | 69.2 | 1.58 | 54.7 | 28.5 | 60.7 | 34.1 |

Table 16 (continued).

| Year | PRW01 | PRW02 | PRW03 | PRW04 | PRW05 | PRW06 |
|---|---|---|---|---|---|---|
| 2001 | | | | | | |
| 2002 | 64.3 | 1.56 | 51.2 | 21.9 | 56.0 | 27.8 |
| 2003 | | | | | | |
| 2004 | 57.4 | 1.40 | 44.1 | 19.3 | 49.3 | 22.9 |
| 2005 | 61.8 | 1.61 | 47.5 | 21.7 | 53.9 | 26.1 |
| 2006 | 54.7 | 1.52 | 40.1 | 16.1 | 47.2 | 19.5 |
| 2007 | | | | | | |
| 2008 | 60.8 | 1.50 | 44.6 | 19.8 | 53.6 | 26.3 |
| 2009 | | | | | | |
| 2010 | 60.8 | 1.34 | 42.9 | 21.3 | | |
| 2011 | | | | | | |

Table 17

*CEPAL and SEDLAC Mexican Rural Welfare Data: PRW06 – PRW12*

| Year | PRW07 | PRW08 | PRW09 | PRW10 | PRW11 | PRW12 |
|---|---|---|---|---|---|---|
| 1980 | 7.8% | 19.5% | 2.51 | | | |
| 1981 | 8.5% | 20.0% | 2.35 | | | |
| 1982 | 9.2% | 20.4% | 2.21 | | | |
| 1983 | 9.9% | 20.8% | 2.10 | | | |

Table 17 (continued).

| Year | PRW07 | PRW08 | PRW09 | PRW10 | PRW11 | PRW12 |
|---|---|---|---|---|---|---|
| 1984 | 10.6% | 21.2% | 2.00 | | | |
| 1985 | 11.3% | 21.6% | 1.92 | | | |
| 1986 | 11.8% | 21.7% | 1.84 | | | |
| 1987 | 12.3% | 21.9% | 1.78 | | | |
| 1988 | 12.9% | 22.1% | 1.71 | | | |
| 1989 | 13.4% | 22.2% | 1.66 | 35.5 | 14.8 | 8.7 |
| 1990 | ... | ... | ... | | | |
| 1991 | ... | ... | ... | | | |
| 1992 | ... | ... | ... | 39.4 | 15.2 | 7.9 |
| 1993 | 2.4% | 0.3% | 0.13 | | | |
| 1994 | ... | ... | ... | 40.6 | 16.0 | 8.6 |
| 1995 | 4.7% | 0.9% | 0.20 | | | |
| 1996 | 3.7% | 0.6% | 0.15 | 59.2 | 28.3 | 17.7 |
| 1997 | 2.6% | 0.5% | 0.20 | | | |
| 1998 | 2.3% | 0.3% | 0.13 | 55.0 | 24.9 | 14.6 |
| 1999 | 1.7% | 0.3% | 0.19 | | | |
| 2000 | 1.6% | 0.3% | 0.20 | 47.1 | 20.1 | 11.5 |
| 2001 | 1.7% | 0.3% | 0.18 | | | |
| 2002 | 5.2% | 0.3% | 0.06 | 39.3 | 15.6 | 8.4 |
| 2003 | 5.5% | 0.3% | 0.06 | | | |

Table 17 (continued).

| Year | PRW07 | PRW08 | PRW09 | PRW10 | PRW11 | PRW12 |
|---|---|---|---|---|---|---|
| 2004 | 6.5% | 0.3% | 0.05 | 32.5 | 13.8 | 7.7 |
| 2005 | 4.5% | 0.4% | 0.08 | 30.3 | 12.1 | 6.7 |
| 2006 | 3.6% | 0.4% | 0.11 | 24.9 | 8.7 | 4.4 |
| 2007 | 3.7% | 0.4% | 0.10 | | | |
| 2008 | 4.0% | 0.4% | 0.10 | 30.2 | 11.4 | 6.1 |
| 2009 | 5.5% | 0.4% | 0.07 | | | |
| 2010 | 7.9% | 0.4% | 0.05 | 27.8 | 10.9 | 5.9 |
| 2011 | | | | | | |

Table 18

*SEDLAC Mexican Rural Welfare Data: PRW13 – PRW18*

| Year | PRW13 | PRW14 | PRW15 | PRW16 | PRW17 | PRW18 |
|---|---|---|---|---|---|---|
| 1982 | | | | | | |
| 1983 | | | | | | |
| 1984 | | | | | | |
| 1985 | | | | | | |
| 1986 | | | | | | |
| 1987 | | | | | | |
| 1988 | | | | | | |

Table 18 (continued).

| Year | PRW13 | PRW14 | PRW15 | PRW16 | PRW17 | PRW18 |
|---|---|---|---|---|---|---|
| 1989 | 59.4 | 27.4 | 16.6 | 32.6 | 13.3 | 7.9 |
| 1990 | | | | | | |
| 1991 | | | | | | |
| 1992 | 62.0 | 29.0 | 17.0 | 44.1 | 17.3 | 9.1 |
| 1993 | | | | | | |
| 1994 | 64.9 | 30.0 | 17.8 | 45.7 | 18.7 | 10.2 |
| 1995 | | | | | | |
| 1996 | 78.8 | 44.0 | 29.6 | 45.4 | 20.6 | 12.5 |
| 1997 | | | | | | |
| 1998 | 73.9 | 40.1 | 26.1 | 51.1 | 22.7 | 13.1 |
| 1999 | | | | | | |
| 2000 | 69.6 | 34.8 | 21.8 | 51.2 | 22.3 | 12.9 |
| 2001 | | | | | | |
| 2002 | 63.1 | 29.1 | 17.3 | 45.6 | 18.7 | 10.3 |
| 2003 | | | | | | |
| 2004 | 54.2 | 25.1 | 15.2 | 40.4 | 17.5 | 10.1 |
| 2005 | 51.8 | 23.1 | 13.6 | 39.8 | 16.5 | 9.4 |
| 2006 | 46.6 | 19.1 | 10.4 | 37.5 | 14.1 | 7.4 |
| 2007 | | | | | | |
| 2008 | 51.8 | 22.6 | 13.0 | 40.9 | 16.9 | 9.4 |

Table 18 (continued).

| Year | PRW13 | PRW14 | PRW15 | PRW16 | PRW17 | PRW18 |
|---|---|---|---|---|---|---|
| 2009 | | | | | | |
| 2010 | 47.9 | 21.0 | 12.3 | 35.7 | 15.0 | 8.4 |
| 2011 | | | | | | |

Non-poverty variables are measured in each model. Financial opportunity (FO) is measured as the median income (in constant 2009 dollars) of Hispanics in the United States. This data is drawn from the United States Department of Labor, Bureau of Labor Statistics. Strength of common cultures (CV) is measured as the average number of personal Chicano relationships of Mexican immigrants in the United States, drawn from the Office of Population Research at Princeton University (OPR). The summary of government policy of the receiving country (GP) uses as a proxy, the number of deportations during the first crossing from Mexico to the United States of heads of households, and is drawn from the Office of Population Research at Princeton University (OPR). The Office of Population Research collects information on multiple crossings of individuals entering the United States from Mexico, demonstrating a pattern of return migration. Since the first crossing is assumed to be seminal for an individual in a dual country residency, the first crossing is considered the most important. The average Hispanic unemployment rate in the United States is used as a proxy for ease of relocation (RE) and is drawn from the United States Department of Labor, Bureau of Labor Statistics. The criteria for these data selections are based on the availability of data over the years assessed, uniqueness of the data that is avoiding multicollinearity, and relatedness of the data to rural Mexico. This study includes the dependent variable, net migration from Mexico (M), as well as the non-poverty independent variables personal relationships (CV), average head-of-household deportation rate at first border crossing into the United States (GP), and the unemployment rate of Hispanic immigrants in the United States.  Data are summarized in Table 19.

Table 19

*Regression Data of Migration Rates and Non-poverty Measures*

| Year | Net Migration from Mexico to the U.S. | Personal Hispanic Relationships in the U.S. | Avg HofH Deportations First Crossing | Immigrant Unemployment in the U.S. |
|---|---|---|---|---|
| 1980 | -245,000 | 0.457 | 0.40 | 10.1 |
| 1981 | -228,000 | 0.442 | 0.89 | 10.4 |
| 1982 | -156,000 | 0.349 | 0.79 | 13.8 |
| 1983 | -159,000 | 0.343 | 0.69 | 13.7 |
| 1984 | -218,000 | 0.452 | 0.89 | 10.7 |
| 1985 | -262,000 | 0.399 | 0.84 | 10.6 |
| 1986 | -268,000 | 0.403 | 0.57 | 10.6 |
| 1987 | -275,000 | 0.431 | 0.33 | 8.8 |
| 1988 | -332,000 | 0.469 | 0.40 | 8.1 |
| 1989 | -432,000 | 0.409 | 0.32 | 8 |
| 1990 | -408,000 | 0.451 | 0.22 | 8.2 |
| 1991 | -374,000 | 0.467 | 0.51 | 10 |
| 1992 | -309,000 | 0.352 | 0.32 | 11.6 |

Table 19 (continued).

| Year | Net Migration from Mexico to the U.S. | Personal Hispanic Relationships in the U.S. | Avg HofH Deportations First Crossing | Immigrant Unemployment in the US |
|---|---|---|---|---|
| 1993 | -341,000 | 0.369 | 0.40 | 10.7 |
| 1994 | -396,000 | 0.458 | 0.38 | 9.9 |
| 1995 | -415,000 | 0.349 | 0.44 | 9.3 |
| 1996 | -415,000 | 0.272 | 0.46 | 8.9 |
| 1997 | -415,000 | 0.225 | 0.44 | 7.7 |
| 1998 | -508,000 | 0.209 | 0.60 | 7.2 |
| 1999 | -651,000 | 0.225 | 0.30 | 6.5 |
| 2000 | -424,000 | 0.234 | 0.63 | 5.7 |
| 2001 | -590,000 | 0.282 | 0.24 | 6.6 |
| 2002 | -564,000 | 0.287 | 0.24 | 7.6 |
| 2003 | -537,000 | 0.217 | 0.64 | 7.7 |
| 2004 | -511,000 | 0.284 | 0.78 | 7.0 |
| 2005 | -485,000 | 0.383 | 0.35 | 6.0 |
| 2006 | -464,000 | 0.512 | 0.60 | 5.2 |
| 2007 | -443,000 | 0.227 | 0.60 | 5.7 |
| 2008 | -422,000 | 0.375 | 0.60 | 7.7 |
| 2009 | -401,000 | 0.120 | - | 12.1 |
| 2010 | -380,000 | 0.333 | - | 12.5 |
| 2011 | -368,000 | - | - | 11.5 |

The research question is whether changes in personal rural welfare, financial opportunity in the United States, the draw of cultural value sharing in the receiving country, the general policy and effectiveness of the receiving country's migration law, or cost of relocation affect net Mexican migration. The breadth of this question begins to unwrap whether and to what extent decreased welfare and lost employment in rural Mexico, of which agriculture is a significant portion, results in measurable emigration of the rural Mexican population to locations of economic opportunity especially to the United States.

$H_o$: Lost rural welfare in Mexico *does not* cause measurable increases in net Mexican migration to the United States.

$H_1$: Lost rural welfare in Mexico results in measurable increases in net Mexican migration to the United States.

Has financial opportunity specifically in United States affected net Mexican migration?

$H_o$: Financial opportunity in the United States *does not* cause measurable increases in net Mexican migration to the United States.

$H_1$: Financial opportunity in the United States results in measurable increases in net Mexican migration to the United States.

Does cultural value sharing available to Mexican immigrants in the United States, as seen in the number of Hispanic relationships of immigrants, positively affect net migration?

$H_o$: Shared cultural values in relationships available to Mexican immigrants in the United States *do not* result in measurable increases in net Mexican migration to the

United States.

$H_1$: Shared cultural values in relationships available to Mexican immigrants in the United States result in measurable increases in net Mexican migration to the United States.

Have increases in United States restrictive immigration policies reduced net rural Mexican migration?

$H_o$: Increases in United States restrictive immigration policies *do not* result in decreased net rural Mexican migration to the United States.

$H_1$: Increases in United States restrictive immigration policies result in decreased net rural Mexican migration to the United States.

Have increased costs of relocation to United States negatively affected net rural Mexican migration?

$H_o$: Increased costs of relocation to United States *do not* result in measurable decrease net Mexican migration to the United States.

$H_1$: Increased costs of relocation to United States result in measurable decreased rural Mexican migration to the United States.

## Findings

Eighteen regression models are evaluated to measure effect on net Mexican migration of measures of rural Mexican poverty, financial opportunity in the United States, common values in the form of culturally based relationships found by Mexicans in the United States, migration policy-driven activities of the United States government, and of measures of ease of relocation in the United States.

The regression analysis model using Mexican rural poverty percentage of the rural population from the World Bank provides low adjusted R-square scores and model significance and is, thus ignored. This is also true of the model using the calculated rural/urban poverty ratio from the World Bank and the nine models using the Foster, Greer, Thorbecke (FGT) poverty indicator regressions using data provided by SEDLAC and so all are dismissed from consideration.

Table 20

*Regression Summary by Mexican Rural Welfare Indicators*

| Source / R Square | Model: Adj R Square | Obs. | Sig. F | Variables: IV | Coef | p-value | 1-tail |
|---|---|---|---|---|---|---|---|
| World DataBank, World Development Indicators | | | | | | | |
| WDI/GDF Poverty Headcount Ratio at Rural Poverty Line | | | | | | | |
| 0.5507 | 0.0109 | 10 | 0.5221 | none | | | |
| Calculated Rural to Urban Poverty Ratio (Rural percent / Urban percent) | | | | | | | |
| 0.5302 | 0.0570 | 10 | 0.5549 | none | | | |
| Comisión Económica para América Latina y el Caribe; Economic Commission for Latin America and the Caribbean (CEPAL) | | | | | | | |
| Percent Mexican Rural Population in Poverty | | | | | | | |
| 0.7504 | 0.5425 | 12 | 0.074 | | | | |
| | | | | CV | 456,897 | 0.2050 | 0.1025 |
| | | | | GP | 187,880 | 0.1530 | 0.0765 |
| | | | | RE | 33,370 | 0.1370 | 0.0685 |
| Percent Mexican rural Population in Extreme Poverty | | | | | | | |
| 0.7704 | 0.5791 | 12 | 0.0599 | | | | |
| | | | | CV | 512,809 | 0.1260 | 0.0630 |
| | | | | GP | 181,058 | 0.1110 | 0.0555 |
| | | | | RE | 36,725 | 0.1010 | 0.0505 |

Table 20 (continued).

| Source — Model — | | | | — Variables — | | | |
|---|---|---|---|---|---|---|---|
| R Square | Adj R Square | Obs. | Sig. F | IV | Coef | p-value | 1-tail |
| Percent Mexican Rural Households in Poverty | | | | | | | |
| 0.8287 | 0.6859 | 12 | 0.0269 | | | | |
| | | | | PRW | 10,197 | 0.1220 | 0.0610 |
| | | | | CV | 580,899 | 0.0410 | 0.0205 |
| | | | | GP | 208,308 | 0.0500 | 0.0250 |
| | | | | RE | 36,583 | 0.0530 | 0.0265 |
| Percent Mexican Rural Households in Extreme Poverty | | | | | | | |
| 0.8493 | 0.7237 | 12 | 0.0188 | | | | |
| | | | | PRW | 11,980 | 0.0780 | 0.0390 |
| | | | | CV | 618,370 | 0.0270 | 0.0135 |
| | | | | GP | 200,754 | 0.0410 | 0.0205 |
| | | | | RE | 38,844 | 0.0360 | 0.0180 |
| Calculated | Total Mexican Unemployment Rate G= [ e/(c+e) ] | | | | | | |
| 0.8478 | 0.8098 | 26 | 0.0000 | | | | |
| | | | | FO | (3.77450) | 0.1340 | 0.0670 |
| | | | | CV | 469,828 | 0.0090 | 0.0045 |
| | | | | GP | 155,365 | 0.0250 | 0.0125 |
| | | | | RE | 24,841 | 0.0080 | 0.0040 |
| Calculated | Rural to Total Unemployment Ratio H=[ f/(d+f) ] | | | | | | |
| 0.8538 | 0.8173 | 26 | 0.0000 | | | | |
| | | | | CV | 397,173 | 0.0250 | 0.0125 |
| | | | | GP | 140,635 | 0.0400 | 0.0200 |
| | | | | RE | 24,435 | 0.0070 | 0.0035 |
| Calculated | Mexican Rural to Total Employment Ratio (H /G) | | | | | | |
| 0.8581 | 0.8226 | 26 | 0.0000 | | | | |
| | | | | CV | 369,750 | 0.0340 | 0.0170 |
| | | | | GP | 126,400 | 0.0690 | 0.0345 |
| | | | | RE | 24,183 | 0.0070 | 0.0035 |

Table 20 (continued).

| Source —— Model —— | | | | —— Variables —— | | | |
|---|---|---|---|---|---|---|---|
| R Square | Adj R Square | Obs. | Sig. F | IV | Coef | p-value | 1-tail |
| Socio-Economic Database for Latin America and the Caribbean (SEDLAC) | | | | | | | |
| Rural Headcount FGT(0) - USD 2.5 a Day Poverty Line | | | | | | | |
| 0.5301 | 0.0602 | 11 | 0.4490 | none | | | |
| Poverty Gap FGT(1) - USD 2.5 a Day Poverty Line | | | | | | | |
| 0.5243 | 0.0487 | 11 | 0.4587 | none | | | |
| Poverty and Inequality FGT (2) - USD 2.5 a Day Poverty Line | | | | | | | |
| 0.5241 | 0.0482 | 11 | 0.4591 | none | | | |
| Rural Headcount FGT(0) - USD 4 a Day Poverty Line | | | | | | | |
| 0.5287 | 0.0574 | 11 | 0.4513 | none | | | |
| Poverty Gap FGT(1) - USD 4 a Day Poverty Line | | | | | | | |
| 0.5289 | 0.0577 | 11 | 0.4511 | none | | | |
| Poverty and Inequality FGT (2) - USD 4 a Day Poverty Line | | | | | | | |
| 0.5269 | 0.0537 | 11 | 0.4545 | none | | | |
| Rural Headcount FGT(0) - Poverty Lines: 50 percent Median household per capita income | | | | | | | |
| 0.5321 | 0.0641 | 11 | 0.4457 | none | | | |
| Poverty Gap FGT(1) - Poverty Lines: 50 percent Median household per capita income | | | | | | | |
| 0.5310 | 0.0620 | 11 | 0.4475 | none | | | |
| Poverty and Inequality FGT (2) - Poverty Lines: 50 percent Median household per capita income | | | | | | | |
| 0.5355 | 0.0709 | 11 | 0.4399 | none | | | |

Seven regression models provided acceptable adjusted R-square results and model significance. These reflect personal rural welfare in Mexico measuring poverty and unemployment from the Comisión Económica para América Latina y el Caribe or Economic Commission for Latin America and the Caribbean (CEPAL). In each model increases in the number of Hispanic relationships in the United States, a proxy of common value sharing (CV); increases in the number of deportations of head-of-household on first migration attempt, a proxy for active enforcement of government migration policy (GP); and increases in Hispanic unemployment in the United States, a proxy for all of the costs of relocation (RE), result in reduced migration.

Of these seven, four directly reported measures of personal rural welfare from CEPAL possess minimal data points needed for a robust regression model and demonstrate Durbin-Watson tests that show positive serial correlation of the predictor variables. There is, therefore, no useable evidence that the independent variables of those four models predict migration from Mexico to the United States. These are percent Mexican rural population in poverty, percent Mexican rural population in extreme poverty, percent Mexican rural households in poverty, and percent rural households in extreme poverty. Three models, however, possess an acceptable number of data points, 26, and are not shown by the Durbin-Watson test to exhibit positive serial correlation of predictor variables. These are total Mexican unemployment rate, Mexican rural to total unemployment ratio, and Mexican rural to total employment ratio.

Table 21

*Durbin-Watson Statistic Values*

| Model, IV | k | n | D | DW table used | p-value | DL | DU |
|---|---|---|---|---|---|---|---|
| Percent Mexican Rural Population in Poverty | | | | | | | |
| CV | 6 | 12 | 0.1878743 | 5% | .0125 | .268 | 2.832 |
| GP | 6 | 12 | 0.1878743 | 5% | .0765 | .268 | 2.832 |
| RE | 6 | 12 | 0.1878743 | 5% | .0685 | .268 | 2.832 |
| D is below $d_L$. There is evidence of positive autocorrelation among residuals. | | | | | | | |

Table 21 (continued).

| Model, IV | k | n | D | DW table used | p-value | DL | DU |
|---|---|---|---|---|---|---|---|
| Percent Mexican Rural Population in Extreme Poverty | | | | | | | |
| CV | 6 | 12 | 0.1878743 | 5% | .0630 | .268 | 2.832 |
| GP | 6 | 12 | 0.1878743 | 5% | .0555 | .268 | 2.832 |
| RE | 6 | 12 | 0.1878743 | 5% | .0505 | .268 | 2.832 |
| D is below $d_L$. There is evidence of positive autocorrelation among residuals. | | | | | | | |
| Percent Mexican Rural Households in Poverty | | | | | | | |
| PRW | 6 | 12 | 0.1878743 | 5% | .0610 | .268 | 2.832 |
| CV | 6 | 12 | 0.1878743 | 5% | .0205 | .268 | 2.832 |
| GP | 6 | 12 | 0.1878743 | 5% | .0250 | .268 | 2.832 |
| RE | 6 | 12 | 0.1878743 | 5% | .0565 | .268 | 2.832 |
| D is below $d_L$. There is evidence of positive autocorrelation among residuals. | | | | | | | |
| Percent Mexican Rural Households in Extreme Poverty | | | | | | | |
| PRW | 6 | 12 | 0.1878743 | 5% | .0390 | .268 | 2.832 |
| CV | 6 | 12 | 0.1878743 | 5% | .0135 | .268 | 2.832 |
| GP | 6 | 12 | 0.1878743 | 5% | .0205 | .268 | 2.832 |
| RE | 6 | 12 | 0.1878743 | 5% | .0180 | .268 | 2.832 |
| D is below $d_L$. There is evidence of positive autocorrelation among residuals. | | | | | | | |
| Total Mexican Unemployment Rate | | | | | | | |
| FO | 6 | 26 | 2.151977 | 5% | .0670 | .897 | 1.992 |
| CV | 6 | 26 | 2.151977 | 1% | .0045 | .711 | 1.759 |
| GP | 6 | 26 | 2.151977 | 5% | .0125 | .897 | 1.992 |
| RE | 6 | 26 | 2.151977 | 1% | .0040 | .711 | 1.759 |
| D is below $d_L$. There is no evidence of positive autocorrelation among residuals. | | | | | | | |
| Mexican Rural to Total Unemployment Ratio | | | | | | | |
| CV | 6 | 26 | 2.123034 | 5% | .0125 | .897 | 1.992 |
| GP | 6 | 26 | 2.123034 | 5% | .0200 | .897 | 1.992 |
| RE | 6 | 26 | 2.123034 | 1% | .0035 | .711 | 1.759 |
| D is below $d_L$. There is no evidence of positive autocorrelation among residuals. | | | | | | | |
| Mexican Rural to Total Employment Ratio | | | | | | | |
| CV | 6 | 26 | 2.121035 | 5% | .0170 | .897 | 1.992 |
| GP | 6 | 26 | 2.121035 | 5% | .0345 | .897 | 1.992 |
| RE | 6 | 26 | 2.121035 | 1% | .0035 | .711 | 1.759 |
| D is below $d_L$. There is no evidence of positive autocorrelation among residuals. | | | | | | | |

The net Mexican migration rate to United States averages 387,375 persons annually from 1980 to 2011. In the three remaining models using CEPAL measures of poverty for rural Mexican welfare, increases in the Hispanic unemployment rate in the United States (RE) by one percent results in a 6.3 percent decrease of the annual migration rate (24,486 persons). In these models an increase by one in the average deportations of the head-of-household per year on first attempt at migration (GP) results in a decrease in annual migration of 36.3 percent (140,800 persons). In these models an increase of one in the few number of meaningful Hispanic relationships (CV) in the United States as tracked by the Office of Population Research (OPR) results in a decrease in the migration rate of 106 percent (412,250 persons). Financial opportunity (FO) is statistically significant in one model that includes total Mexican unemployment rate as a measure of personal rural welfare, but the coefficient is very small (3.8) and so is dismissed from consideration.

The model that uses the total Mexican unemployment rate calculated from CEPAL as a measure of rural welfare has R-Square values of .8478 and .8098 and a model significance of .0000. The coefficient for financial opportunity in the United States (FO) is -3.7745 with a one-tail, p-value of.0670. Although statistically valid, the small size of the coefficient, -3.7745, means the effect is insignificant. The coefficient for common cultural sharing (CV) is 469,828 with a one-tail, p-value of.0045. The coefficient is 1.213 more than the average net Mexican migration rate and so an increase of one in the average number of Hispanic relationships in the United States will result in an annual decrease in migration of approximately 469,828 persons. The number of deportations of head-of-household on first migration attempt (GP) in this model has a coefficient of 155,365 and a one-tail, p-value of.0125, meaning that as the number of these deportations, which average .51 from 1980 to 2011, increase by one the annual migration rate is cut by 40.1 percent. The Hispanic unemployment rate in the United States, a measure of ease of relocation (RE) in this model, has a coefficient of 24,841 and a one-tail, p-value of.0040, meaning that as the average Hispanic unemployment rate in the United States, which averages 9.07 from 1980 to 2011, increases by one percent the migration rate is reduced by 6.4 percent, or 24,841 persons.

The model that uses the rural to total Mexican unemployment ratio calculated from CEPAL as a measure of rural welfare has R-Square values of .8538 and .8173 and a model significance of .0000. The coefficient for common cultural sharing (CV) is 397,173 with a one-tail, p-value of .0125. The coefficient is 1.025 more than the average net Mexican migration rate, so an increase of one in the average number of Hispanic relationships in the United States will result in an annual decrease in migration of approximately 397,173 persons. The number of deportations of head of household on first migration attempt (GP) in this model has a coefficient of 140,635 and a one-tail, p-value of.0200, meaning that as the number of these deportations, which average .51 from 1980 to 2011, increase by one the annual migration rate is cut by 36.3 percent. The Hispanic unemployment rate in the United States, a measure of ease of relocation (RE) in this model, has a coefficient of 24,435 and a one-tail, p-value of.0035, meaning that as the average unemployment rate in the United States, which averages 9.07 from 1980 to 2011, increases by one percent the migration rate is reduced by 6.3 percent, or 24,435 persons.

The model that uses the rural to total Mexican employment as a ratio calculated from CEPAL as a measure of rural welfare has R-Square values of .8581 and .8226 and a model significance of .0000. The coefficient for common cultural sharing (CV) is 369,750 with a one-tail, p-value of.0170. The coefficient is 95.5 of the average net Mexican migration rate and so an increase of one in the average number of Hispanic relationships in the United States will result in an annual decrease in migration of approximately 369,750 persons. The number of deportations of head of household on first migration attempt (GP) in this model has a coefficient of 126,400 and a one-tail, p-value of.0345, meaning that as the number of these deportations, which average .51 from 1980 to 2011, increase by one the annual migration rate is cut by 32.6 percent. The Hispanic unemployment rate in the United States, a measure of ease of relocation (RE) in this model, has a coefficient of 24,183 and a one-tail, p-value of.0035, meaning that as the average unemployment rate in the United States, which averages 9.07 from 1980 to 2011, increases by one percent the migration rate is reduced by 6.2 percent, or 24,183 persons.

Lost rural welfare in Mexico demonstrates no increases in net Mexican migration, and in two models there is a modest decrease in migration due to lower rural welfare. This null hypothesis is rejected. Only one of the models shows statistical significance of the effect of financial opportunity in the United States increasing migration. This null hypothesis is rejected, but findings possess such a small coefficient as to make conclusions of little value. The models demonstrated a lessening of migration as the result of increases in shared cultural values in relationships available to Mexican immigrants in the United States. Although expected change ($H_1$) is to increase migration, the coefficient indicates that as cultural values increase migration decreases. This null hypothesis is rejected. Increases in the enforcement of restrictive United States immigration policies and increases in costs of relocation measured in increased Hispanic unemployment in the United States have statistical and measurable effect on decreasing net Mexican migration to the United States. These null hypotheses are rejected.

## Analysis

Analysis of eighteen models, each with separate measures of personal rural welfare in Mexico show that only three provide viable predictions of net Mexican migration to the United States. Four provide meaningful significance values, but are shown to possess significant serial correlation among the predictor variables.  Eleven regression analyses provide poor fit and are ignored. These regression models include the Mexican rural poverty headcount percentage of the rural population and the calculated rural/urban poverty ratio from the World Bank, and the nine Foster, Greer, Thorbecke (FGT) poverty indicator models from SEDLAC.

Three regression models show statistical significance for the independent variables. In each of these models the percent of Hispanics unemployed in the United States, the average number of deportations of heads of households on first border crossing into the United States and the number of personal friends from Mexico an immigrant has in the United States show inverse relationship to the net Mexican migration rate. None of the regression models show significant p-values without serial correlation for measures of personal rural welfare.

These models show that with probabilities at 95 percent that for every percent that Hispanic unemployment in the United States increases the net Mexican migration into the United States decreases by approximately 24,486 persons. The average net Mexican migration rate of 387,375 from 1980 to 2011 is assumed (United States Department of Commerce, United States Census Bureau, 2012) this is a decrease of 6.3

percent. This conclusion is expected from migration theory presented by Kuznets (1955, 1971), Papademetriou (2008) and Ravenstein (1885). Non-diaspora migration is most often driven by financial incentives.

These models also show with probabilities at or above 95 percent, as the average number of deportations of heads of household on first border crossing into the United States increases by one the net migration from Mexico into the United States decreases by 40,800 per year or 3.3 percent. These findings are consistent with Fitzgerald (2006), Delgado-Wise, Kolesnikova, and Taylor (2007), Novoa and Sanabria (2008), and Frank and Wildsmith (2005) that a receiving country's immigration policies and uncertainties of immigration affect migrant patterns.

Surprisingly, these models also show with probabilities near or above 95 percent that as the number of personal Chicano relationships in the United States increase by one, net migration from Mexico into the United States decreases from, 412,250 per year or 106 percent. This is counter-intuitive to findings of Aguilera-Guzman et al. (2004) who show the importance of common cultural values in the destination locations in the United States. The coefficients for this causal variable are so strong as to predict a pattern of reverse migration. This implies that, although interpersonal relationships are important to immigrants, they provide an inverse incentive to further migration or provide an incentive for return migration paths.

Financial opportunity is statistically significant in one model: total Mexican unemployment rate. The causal variable, financial opportunity, is measured as the median income of Hispanics in the United States on an annual basis. This significance could be partially the result of crowding out by other Latinos as that population segment grows and Hispanic labor niches experience adequate labor supply and driving down wages. The coefficient is very small, so it is dismissed from consideration. The relationships shown here may be most reflective of the impact of the independent variables on the rural Mexican family. Although lacking strong probability, these findings indicate a tendency for family members of the very poor to not migrate. This may be due to the need for immediate family members to remain at home or might indicate that at these levels of poverty physical or monetary capacity to migrate do not exist.

## Conclusions

Available United States census data indicates that a large number of Mexican immigrants self-report rural roots (Burstein 2007), but financial capital and physical ability may be more influential in migration and these assets may be the result of intermediate migration steps, such as migration to larger Mexican communities and then to the United States.

It is expected that in the last two decades as the employment opportunity decreases and poverty increases in rural Mexico there is a corresponding increase in emigration from rural Mexico directly to locations of opportunity in the United States. This is not the case from observed data. Financial opportunity and decreased personal welfare confirm migration incentives, but available data does not show a link between rural Mexican poverty and net Mexican migration to the United States. Finally, increases in cultural relationships in the United States, United States deportation rates, and Hispanic unemployment in the United States significantly lower net Mexican migration rates.

More survey data of rural Mexico is needed. Although Mexican poverty data is available, most measures of rural poverty data in Mexico is limited, consisting of 1989 and biannual data from 1992. Secondary indicators of rural well-being are also scarce. Consistent with Hernandez and Szekely (2009) and Székely's (2005) recommendations, more time-series data is needed for more robust rural poverty assessment in Mexico, and these more robust models will confirm currently observed trends and migration incentives.

# CHAPTER V

# CONCLUSIONS

The inclusion of Mexico into the North American Free Trade Agreement (NAFTA) forming a trilateral trade bloc composed of the United States, Canada, and Mexico on January 1, 1994 caused concern within each of the member countries. These concerns ranged from loss of rights to fairness to questions of effectiveness of free trade. Baghwati (2004) clearly outlines the benefits of free trade, but Stiglitz and Charlton (2005) caution about population segments that lose as free trade is implemented.

There is concern that the heavily subsidized domestic corn production leads to unfair trade advantages with Mexico in agriculture. The subsequent concern is that as low cost yellow corn is sold into Mexico large portions of the Mexican agriculture sector are displaced and experience increases in poverty. Lastly, there is concern that as income decreases in the Mexican rural sector that population is incentivized to migrate to locations of opportunity in larger Mexican cities and to the United States.

Research findings show from 1986 to 2007, as the United States/Mexico ratios of fertilizer, farm equipment, and general governmental support (GSSE) of agriculture increase, exports of corn to Mexico increase. Total production ratios, land production efficiency ratios, personal subsidy to the individual farmer (PSE) ratios, and consumer subsidy (CSE) ratios between the two countries do not predict increases in exports of corn from the United States to Mexico. Research findings also show that increases in rural poverty in Mexico are predicted by changes in the general governmental support (GSSE) of agriculture ratio between the United States to Mexico. Increases in imported corn from the United States, personal subsidy to the individual farmer (PSE) ratios, and consumer subsidy (CSE) ratios between the two countries do not predict increases in rural poverty in Mexico. Research findings show migration from Mexico to the United States is not affected by personal rural welfare, but is negatively affected by Hispanic unemployment in the United States, the number of deportations of heads of household on first immigration attempt, and the number of personal Hispanic friends in the United States while in the country.

In summary, this research shows that a domestic corn subsidy to United States farmers does not affect corn exports to Mexico. Increases in exports of corn to Mexico from the United States do not predict an increase in Mexican rural poverty, and levels of rural Mexican poverty from 1980 to 2010 are not seen to affect Mexican migration to the United States.

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